ΚΟΣΜΟΣ.

ΚΟΣΜΟΣ:

A

General Survey

OF

THE PHYSICAL PHENOMENA

OF THE

UNIVERSE.

BY

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KOSMOS:

A GENERAL SURVEY OF THE PHYSICAL PHENOMENA OF THE UNIVERSE.

INDUCEMENTS TO THE STUDY OF NATURE.

THE ACTION OF THE EXTERNAL WORLD UPON THE IMAGINATION.—POETICAL DESCRIPTION OF NATURE.—LANDSCAPE PAINTING.—THE CULTIVATION OF EXOTIC PLANTS, SHEWING THEIR DISPOSITION TO FORM A COVERING FOR THE SURFACE OF THE EARTH.

WE proceed from the sphere of Objects to that of Feelings. The principal results of observation, as stripped of all imagination, and belonging to a purely scientific and objective description of Nature, have been already laid down in strict order in the first volume of this work, under the form of a Picture of Nature. We will now contemplate the effect of the impressions of the Senses upon the feelings and the imagination. An inner world is opened to us. We investigate it, not for the purpose of searching into this Book of Nature, as is required by the Philosophy of Art, for that which,

in its possible and sensible effects, suits the actual powers of the mind and the manifold aim of an energetic spirit, but rather to point out the source of lively ideas and views, as a means of calling forth a pure love for Nature, and to inquire into the causes, which, especially in latter times, by the aid of an active imagination have had so powerful an effect upon the love for this study, and the inclination for travelling into distant regions.

The inducements, as I have before remarked, (1) are of three kinds: sensible representation of natural scenes, with lively delineations of the animal and vegetable kingdoms, a very modern branch of literature; painting from Nature, especially as this has begun to include the characters of the growth of plants, and the more extended cultivation of tropical plants, and the comparison and apposition of exotic specimens.

Each of these inducements, taken in its historical relations, might be made the subject of a much more extended discussion; but it appears to be more appropriate to the spirit and the end of my work to develope only a few leading ideas, and then to remember how the natural world, at different epochs and in different races, has variously affected the world of thoughts and feelings, and how, in a condition of general cultivation, the strictest science and the softer enticements of the fancy mutually tend to advance one another. In order to represent Nature in all her sublime magnitude, we must not dwell only upon external phenomena, we must exhibit her as she is reflected in the mind of man, and as she thereby peoples the misty region of fables with attractive forms, or unfolds the noble germ of the art of pictorial representation.

As we shall here limit ourselves to the simple consideration of the inducements to a scientific study of Nature, let us first remember the well-known and oft-repeated result of experience,—how impressions upon the senses or circumstances, which appear to be accidental, determine, in the minds of the young, the entire aim of a man's life. Childish joy at the form of countries and lakes (2), as they are represented in maps, the desire to contemplate the southern constellations which are not visible in our hemisphere (3), pictures of the palm-trees and cedars of Lebanon in the pictorial Bibles, may implant in the mind the earliest desire to travel into distant lands. If I might be permitted to bring forward my own recollections, and to ask what gave the first impulse to my insatiable longing after tropical climates, I should say—"George Forster's Delineations of the South Sea Islands;" Pictures of Hodges, representing the Banks of the Ganges, at the house of Warren Hastings, in London; and a colossal dragon-tree in an old tower of the Botanical Garden at Berlin. The objects which I have here enumerated as examples belong to the three classes of inducements which I have before denoted, viz.: to the description of Nature as it originates from an animated view of terrestrial life; the art of representing objects, as the drawing of landscapes; and the immediate and actual examination of characteristic natural forms. But these inducements exercise their influence only when the condition of modern cultivation, and a peculiar direction in the development of the mind, with the aid of original talent, have rendered us more susceptible of the impressions of Nature.

I. THE DESCRIPTION OF NATURE.—NATURAL FEELINGS ACCORDING TO THE DIFFERENT EPOCHS AND RACES.

It has been often said, that the pleasure derived from the contemplation of Nature, although not unknown to the ancients, was nevertheless alluded to by them, as an expression of feeling in much more sparing and less lively terms than has been the case in more modern times. "If we remember," says Schiller (4), in his Considerations upon Simple and Sentimental Imagination, "the beauties of Nature which surrounded the ancient Greeks; if we think how confidingly they lived in that happy climate, how very near their modes of thought and sensibilities, and their manners were to the simplicity of Nature, and how truly they are expressed in their works of fiction, we must be surprised by observing that we meet with so few traces of that interest and sentiment which we are in the habit of attaching to characteristic natural scenes. The Greek is, to the greatest degree, accurate, true and circumstantial in his descriptions; but he shews no more heart-felt interest in them than in the account of a dress, a shield, or a preparation for war. Nature appears to affect his intellect more than his moral feelings; he dwells upon her beauties with none of the fervour and sweet melancholy which is felt by us." Although

so much that is true and exact, even in particulars, is here expressed, yet we cannot extend this reflection to the entire ancient world. We may, too, call that a narrow view which includes only the Grecian and Roman Empires under the term 'Antiquity,' as distinguished from modern times. Deep natural feeling is apparent in the oldest works of the Hebrews and Indians, as well as among people of a very different origin, namely, the Semitic and Indo-Germanic races.

We can only draw our conclusions respecting the state of feelings among the ancient races from the expressions which we find in their literary remains: we must, therefore, more carefully investigate them, and judge of them with so much the more prudence, as they are but sparingly presented to us in the form of Epic and Lyric poems. In Grecian antiquity and in the flower of their manhood we certainly meet with the warmest expressions of deep natural sensibility, and with poetical descriptions of human emotions, mixed with a borrowed account of traditional history: but genuine description of Nature is only seen as a secondary object, because everything in Grecian art moves only in the circle of which Man himself is the centre.

The description of Nature in her manifold richness of form, and as a special branch of literature, was entirely unknown to the Greeks. A landscape itself only appeared to them as the distance of a picture, in the fore-ground of which human forms are to be seen. Emotions bursting forth into actions almost exclusively occupied their minds, and a public and active life prevented them from sinking down to the obscurity of the quiet path of Nature.

Physical phenomena were always noticed in their relation to Man(5), whether in their comparisons of external forms, or of internal motives for action. In such a comparative view, the study of Nature was considered, in the perceptible form of an allegorical representation, to be worthy only of being introduced as small, separate and living pictures into the province of poetry.

At Delphi, hymns in praise of Spring were sung,(6) intended probably to express the joy of mankind at the termination of the period of necessity during the winter. A natural description of winter is interwoven with the works of Hesiod (7), a rhapsody, introduced perhaps by the strange hand of some Ionian writer. This poem gives instructions in agriculture, rules for business and work, and ethical precepts for blameless conduct. It is only elevated to the standard of a lyric poem when the author clothes in a human form the miseries of mankind, or narrates the beautiful allegory of Epimetheus and Pandora. In the Theogony of Hesiod, too, which is put together from very different ancient portions, we find, for example, accounts of the Nereïdes (8), and a description of Neptune's kingdom, hidden under the significant names of Mythical persons. In the Bœotian school of poetry, and especially in all the older specimens of poetical art, they have recourse to the phenomena of the external world only for the sake of personifying them.

If, as I have above remarked, the description of natural objects, whether it is an account of the rich and luxuriant vegetation of tropical climates, or spirited delineations of the habits of animals, have become a special branch of literature only in later times, it merely shows, that where

so much sensibility existed, the susceptibility for the beauties of Nature was wanting; and that when the energetic powers of the Greeks brought forth inimitable masterpieces in poetry and the arts, lively mental impressions from the contemplation of the beauties of Nature, were absent (9). According to this view, and with the feelings of our more modern tastes and dispositions, that which we find too sparingly in the ancient world, testifies in a negative way, not so much the want of susceptibility, as of a strong and active desire to convey in words a sense of the beauties of Nature. Connected as they were, less with the phenomena of the inanimate world than with a busy life, and with the internal and spontaneous excitement of the feelings, the earliest as well as the noblest direction of the spirit of poetry, was towards the Epic and the Lyric forms. In these artificial poems, natural delineations could only be introduced here and there. They do not appear as distinct productions of the imagination. As soon as the influence of the Old World died away, and its blossoms withered, Rhetoric gradually entered into descriptive as well as into didactic instructive poetry. This was earnest, noble, and unadorned, in the most ancient, philosophical, and almost priest-like form, such as the poem of Empedocles. Rhetoric gradually deprived it of its simplicity, and much of its former worth.

We may here be permitted, in order to illustrate what I have stated generally, to bring forward some separate examples. As the character of Epic poetry requires, in the verses of Homer we only find the most attractive scenes of natural life as a secondary part. "The shepherd rejoices in the quiet of the night, the pure air, and the

bright stars in the sky; he perceives in the distance the roaring of the suddenly swollen and muddy mountain-stream, tearing up oak-trees in its rapid course." (10) With the noble description of the solitude of Mount Parnassus and its dark, rocky valleys, with their thick foliage, we may contrast the beautiful picture of the fertile grove of poplar-trees in the Phœacian island; or, again, the land of the Cyclops, where "green meadows, swelling with luxuriant waving grass, encircle the vine-hills, which require no care." (11) Pindar, in a dithyrambus, in praise of Spring, which he caused to be represented at Athens, sings of "the earth covered with new blossoms, when the first bursting sprout of the palm-trees in the forest of Nemea, in Argolis, has announced the coming of fragrant Spring." He sings of Mount Ætna, "The pillar of Heaven, the supporter of eternal snows;" but he quickly passes on from the horrors of inanimate Nature, in order to celebrate Hieron, of Syracuse, and the victorious battles of the Greeks against the mighty race of the Persians.

Let us not forget that the Grecian landscape displays the peculiar beauty of a close union of land and water, of the shore adorned with plants, or picturesque rocks, and of the noisy sea, with the lights and shadows of its dashing waves. Whilst to other nations, the sea and the land, the life of a sailor and that of a landsman, appear to be two distinct spheres in Nature, the Greeks, on the contrary, and not only the inhabitants of the islands, but also those of the southern portion of the continent, were permitted to take at once a view of all the variety and grandeur which result from the contiguity and apposition

of the different elements in a landscape. How was it possible that so sensible and happily situated a people should not be moved by the appearance of the cliffs, covered with trees, in the deep bays of the Mediterranean Sea, or by the quiet of the earth's surface, or of the lower stratum of the atmosphere, and their changes according to the time of the day, and the seasons of the year, or by the distribution of the Vegetable Kingdom? How was it that, in the age when the attachment and disposition for poetry was at its height, every kind of living and sensible elevation of the feeling was resolved into ideal contemplation? The Greek imagined the creation of plants to be in manifold fabulous relation with his Heroes and Gods. They punished and avenged any injury to the sacred trees and shrubs. Their imaginations animated the forms of plants; but the nature of the poems to which the ancient Greeks, from the peculiarity of the development of their minds, limited themselves, gave but a very limited range to the description of scenery.

In isolated places in the tragedies, amidst the storm of excited passions and melancholy feelings, a deep sense of the beauties of Nature bursts forth into a spirited description of natural scenes. When Œdipus approaches the groves of the Eumenides, the chorus sings of "the noble resting place of the glittering Colonus, whither the melodious nightingale willingly flies, and laments in clear-sounding notes." They sing of "the green night of the ivy bushes, of the Narcissus watered by the dews of heaven, of the golden-rayed crocus, and the indestructible and reproductive olive tree." (12) When Sophocles endeavours to glorify the place of his birth, the

district of Colonus, he places the high form of the ill-fated wandering king by the sleepless waters of Cephissus, quietly surrounded by happy figures. The stillness of Nature increases the impression of the pain which the dignified form of the blind man, the victim of destiny, is calculated to call forth. Also Euripedes pleases himself with an artistic description of the "Pastures of Messenia and Laconia, which under a continually warm sky, and nourished by a thousand springs are permeated by the beautiful Pamisus" ([13]).

The Bucolic poetry, originating in the plains of Sicily, and popularly allied to dramatic works, rightly bears the name of a transition form. It represents, in the short Epic verses of the shepherd, rather the Nature of Man than the Landscape. It appears in its most lively form and in perfection in Theocritus. A quiet elegiac form is peculiar to this pastoral poem, as if it originated "from some earnest desire after a lost idea," and as if a certain degree of melancholy was always mixed with the deepest natural feelings in the mind of man.

But as poetry in Greece ceased to exist with the freedom of the life of the people, it became descriptive and didactic, and a means of conveying information. Astronomy, geography, hunting, and fishing became in the time of Alexander the subjects of poetry, adorned frequently with excellent metrical composition. The forms and habits of the Animal Kingdom were represented with life, and with a degree of accuracy so great, that the new classifications of Natural History recognise in their descriptions particular families and even species of animals. But all these writings are entirely wanting in life and

spirit, so important in the contemplation of Nature. It appears that the external world was almost unknown to the poet as a fit subject for the exercise of his imagination. An unusual degree of descriptive power is seen in the forty-eight little pieces, remarkable for their skilful versification, the Dionysiaca of the Egyptian Nonnus. The poet rejoices in the representation of great natural convulsions. He makes a forest fired by a flash of lightning burn up even the fish in the course of the Hydaspes; he shows how the rising mist assists in producing the meteorological phenomena of a thunderstorm and of electric rain. Nonnus of Panopolis, although inclined to write romantic poetry, is very unequal in his works; being at one time spirited and exciting, at another long-winded and verbose.

More natural feeling and fine sensibility is seen in separate parts of the Greek Anthology, which has reached us in divers ways and from many different periods. In the lively translation of Jacob, everything which refers to animal and vegetable life is compressed into one part. It consists of little pictures, chiefly the reflection and representation of certain individual forms. The plane-tree, which "cherishes the clustering vine in its branches," and which was brought from Asia Minor over the island of Diomede under Dionysius the Elder, as far as the shores of the Sicilian Anapus, has been almost too frequently celebrated in verse. Yet, altogether, the ancient taste in these songs and epigrams appears to be more especially directed to the Animal than to the Vegetable World. A noble and a larger work is the pastoral poem in praise of Spring, by Meleagar, of Gadara in Cœlesyria (14).

On account of the very ancient associations connected with the region, I must mention the picture of the wooded valley of Tempe, which Ælian (15) probably has represented in imitation of Dicæarchus. It is the most complete description of Nature which has come down to us from the Grecian prose writers; it is, indeed, topographical, but at the same time artistic; for the shadowy vale is enlivened by the Pythian processions which break off the expiatory branch from the sacred laurel. In the later Bysantine times, since the fourth century, we see descriptions of landscapes very frequently interwoven with the pure works of Roman and Grecian authors. The Pastorals of Longus (16) are worthy of notice from containing such descriptions; but, still in them tender pictures of life predominate very much over the expression of the natural feelings.

It was not the object of these pages to enter any further into these details, than is sufficient, by special reference to certain individual productions, to illustrate my general remarks upon the poetical perceptions of the external world. I would already leave the blooming age of Grecian antiquity, if, in a work to which I have ventured to prefix the title "Kosmos," I could pass by in silence the natural accounts with which "Kosmos," a pseudo-Aristotelian work upon the order of the world, commences. It introduces to us "the globe of the earth with its luxuriant vegetation, richly watered, and (better than all the rest) inhabited by living and rational beings." (17) The rhetorical colouring of so rich a natural picture, so unlike the concise and scientific mode of treatment of the philosopher of Stagira has ever

been known to be one of the many proofs that this work upon the world is counterfeit. It may belong to Appuleius (18) or Crysippus (19), or, in fact, to any one else.

The natural descriptions, which we do not find in Aristotle, are replaced by a genuine account which Cicero has preserved for us. In a verbal translation from a lost work of Aristotle's, he gives the following account (20): "If there were beings which still inhabited dwellings in the depth of the earth, and whose houses were adorned with statues and pictures, and everything which those who are accounted happy possess in abundance; and if these beings obtained information respecting the power and the might of the gods, and were to step out of their concealment, through some opening in the earth, into the region which we now inhabit; if they were suddenly to look upon the earth and see the vault of the sky, and to recognise the size of the clouds and the power of the winds, and to admire the sun, with its beauty, magnitude, and its rays; if, in fine, as soon as night came on, and shrouded the earth in darkness, they were to see the stars in the sky, the moon with its changes, the rising and setting of the stars, and their continued regular and unchangeable course, they would certainly declare that there are gods, and that these great things are their works." It has been rightly said that these lines alone are sufficient to verify Cicero's sentence concerning "the golden stream of Aristotle's words," (21) that some of the spirited power of the genius of Plato is seen in them. Such a proof of the existence of heavenly Powers, from the beauty and endless grandeur of the works of the Creation, is seldom met with in the writings of antiquity.

That which we so much miss, I do not say in the susceptibility of the Grecian people, but in the aim of their literature and productions, is still more sparingly met with in he works of the Romans. A nation which, according to ancient Siculian habits, was especially addicted to agriculture and rural life, would justify other expectations; but notwithstanding so many opportunities for practical study and activity, the character of the Roman people with their coldness and earnestness, and with their logical and sober intelligence, was decidedly less excitable, and more given to daily realities, than to a contemplative and poetical examination of natural objects.

This difference between the habits of life of the Romans and that of the Grecians is reflected in their literature, the actual expression of the habits of thought of all nations. In addition to this, and notwithstanding their relationship and common origin, there is an acknowledged difference in the structure of the languages of these two nations. The language of ancient Latium possesses less flexibility, a more limited supply of words, "a more realizing tendency," but at the same time a more general applicability to the expression of ideas. Moreover, in the age of Augustus, a strange inclination for the introduction of Greek images prevented the outpouring of their natural humour, and the expression of the real state of their feelings; but some noble spirits, incited by the love of their country, were able, by means of their individual creative faculties, by their elevated ideas, as well as by a delicate and lively style of description, to overcome these difficulties.

The spirited natural poem of Lucretius is richly endowed with poetical genius. It includes an account

of all Creation. Allied to the works of Empedocles and Parmenides, the ancient mode of thought and narration heightens the earnestness of his descriptions. Poetry is more deeply united with Philosophy, without sinking into the "chilliness" of composition which, in contrast with Plato's imaginative natural view, has been already so bitterly censured by the Orator Menander in the sentence which he pronounced upon Physical Poems ([22]).

My brother has shown, with a great deal of ingenuity, the remarkable analogies and differences, which have appeared from the union of metaphysical abstraction with poetry in the ancient Grecian didactic poems, in the works of Lucretius, and in the episode Bhagavad-Gita out of the Indian epic poem Mahabharata ([23]). The great physical delineation of the World by the Roman Poet contrasts, in the cool examination of particulars, and in his occasionally wild hypothetical dreams, with his lively pictures of the transition of the human race from the depths of the woods to agricultural pursuits, to a rule over the powers of Nature, to an elevated cultivation of the intellect, and also to the improvement of language and political society ([24]).

When a statesman in an active and busy life, and with a disposition excited by political passions, preserves his lively natural feelings and a love for the solitude of the country, it originates from the depth of a great and noble character. Cicero's own writings testify the truth of this opinion. At any rate, as is commonly known in his work upon Laws, and in that upon Oratory, he imitates in many parts the Phædrus of Plato ([25]); but the Italian pictures lose none of their individuality. Plato praises,

in general terms, "the dark shades of the richly-leaved plane-tree, the plants with the fragrant fulness of their blossoms, and the breezes softly wafting the summer chorus of the grasshoppers." In Cicero's little description of natural scenery, everything, as has been lately remarked by a clever investigator ([26]), is so represented, that we can, to this day, discover all the particular points in the landscape. We see the Liris, shaded by its lofty poplars ; we recognise, upon descending eastwards from the steep hill behind the ancient town of Arpinum, the grove of oak-trees upon the edge of the brook Fibrennus, and the island now called "Isola di Carnello," which is formed by the division of the streamlet, and whither Cicero used to retire in order, as he said, "to give himself up to meditation, to read, or to write." Arpinum, upon the Volscian Hills, was the birth-place of this great statesman, and the beauty of the scenery in the neighbourhood certainly had an effect upon his disposition in the days of his boyhood. The reflection of the surrounding landscape, whether more or less calculated to excite the feelings, silently becomes interwoven with all that is free and deep in the original talents, among the innermost powers of the mind.

In the middle of the storms, so pregnant with important results, which occurred in the year 708 (after the building of the city) Cicero found pleasure and consolation in his villas, changing from Tusculum and Arpinum, to Cumæ and Antium. "Nothing," says he, in his letter to Atticus ([27]), "can be more delightful than this solitude, nothing more enlivening than this landscape, the shore in the fore-ground and the distant view of the sea. In

the deserted island of Astura, at the mouth of a river of the same name, upon the shore of the Tyrrhenian Sea, no human being disturbs me: and if I bury myself in the early morning in the depth of the thick and wild forest, I do not leave it until evening. Next to my Atticus, nothing delights me so much as solitude, for with its aid I employ myself with scientific pursuits, but they are often interrupted by my tears. I fight against these feelings as much as I am able, but still I am not strengthened by the contest." It has been frequently remarked, that in these letters, and in those of the younger Pliny, we cannot fail to recognize distinct intimations of modern sentiment. I find in them only the voice of deep natural feeling, which, in that age and among that people, burst forth from a heart painfully oppressed with cares.

The acquaintance with the great poetical works of Virgil, Horace and Tibullus, is so closely connected with the general spread of Roman literature, that it would be superfluous to stop to allude to single proofs of the tender and active natural feeling to be found in these writings. In Virgil's national epic poem, from the very nature of the work, the description of natural scenery could only appear here and there, and might only occupy a small space. We do not notice in his work, special descriptions of certain localities, but only an intimate acquaintance with Nature, painted in quiet colours ([23]). Where do we find the gentle sporting of the waves, or the quiet of the night described in more happily chosen terms? How well the powerful representations of the bursting thunder-storms, in the first book of the Georgics, or the voyage and land-

ing at the Strophades, the shipwreck and the account of the Eruption of Mount Etna in the Eneid (29); contrast with these more pleasing pictures. We might have expected from Ovid, as the result of his long sojourn in the plains of Tomi (in Lower Mœsia), a poetical description of the open heaths and moors, no notice of which has been sent down to us from antiquity. In his banishment, he certainly did not see that kind of plain, which in summer, is thickly covered with verdant plants, from four to six feet high, presenting at every breath of wind, the lively picture of moving waves of blossoms; the plain of Ovid's banishment was a desert and boggy moor, and the broken spirit of his unmanly complaints was filled with recollections of the social pleasures of the world, the political occurrences at Rome, and not with the description of the surrounding Scythian desert.

As a kind of compensation, this highly-gifted author, so powerful a painter of living pictures, has only too frequently repeated some general delineations of caves and streams, and "still moon-light nights," and a very special and important geographical account of the volcanic eruption at Methona, between Epidaurus and Trœzen. This description has already been considered in another place in my "Picture of Nature" (30). Ovid shows us how "the vapour, enclosed and compressed, raises up the earth into a hill like a bladder filled with air, or like the skin of a two-horned goat."

It is especially to be lamented that Tibullus has left behind him no great characteristic composition upon the subject of nature and her wonders. Of the poets of the age of Augustus, he is one of the few who, fortunately

unacquainted with the Alexandrian erudition, and addicted to solitude and rural life, full of feelings, and therefore simple-minded, has drawn from his own peculiar fountain. Elegies (31) must really be looked upon as pictures of the habits of the times, in which the landscape forms the back-ground, but the 6th elegy of the 1st book teaches us what might have been expected from the friend of Horace and Messala.

Lucan, the grand-son of M. Annæus Seneca, resembles him too much in his natural style of diction; but nevertheless we find in his writings an excellent and true picture of the destruction of the Druid forest (32) on the present barren coast of Marseilles. The falling trunks of the oak trees tottered and leant one against another; being stripped of their leaves, they permit the first ray of the sun to penetrate into the dread and sacred obscurity. He who has lived for any time in the forests of the New World, feels with what life and how concisely the poet delineates the luxuriance of the growth of the trees, whose gigantic remains still lie buried in some of the peat bogs of France (33).

In "Etna," a didactic poem of Lucilius the younger, a friend of L. Annæus Seneca, the phenomena accompanying the eruption of a volcano are pictured with truth; but the ideas are more free from any special indications of character, than the dialogue "Etna," written by the Younger Bembo, which I have before alluded to in terms of praise (34).

At last, after the second half of the fourth century, the art of poetry, in its greatest and most noble form, withered away as if it was exhausted; and at that time all poetical

attempts, stripped of the charms of creative fancy, were directed simply to the bare realities of science and description. A certain oratorical manner and style could not compensate for the departure from the simplicity of natural feelings and the spirited powers of imagination. As a testimony of this barren time, in which real poetry only appeared accidentally as one of the external ornaments of thought, we may mention the "Mosella" of Ausonius. Born in Gallia Aquitana, the poet lived in the time of the campaign of Valentinian against the Germans. This poem, written in ancient triple verse, celebrates here and there (35), and occasionally with considerable life, the hills around one of the most beautiful of our native rivers; but a dry topographical description of the land, the number of the tributary streams which flow into the Moselle, and the characteristics in point of form, colour and habits of its fish, are the chief subjects which are treated of in this didactic composition.

In the Latin prose works, from which we have already brought forward some very remarkable passages in Cicero, the descriptions of natural scenery are as rare as in the Grecian works. The great historians, indeed, Julius Cæsar, Livy, and Tacitus, present some examples to our notice, where they have been compelled to describe the fields of battle, the crossing of rivers or impracticable mountain-passes, and where they are under the necessity of picturing the struggle of man against natural obstructions. In the annals of Tacitus, I have been charmed with the account of the unhappy voyage of Germanicus upon the Ems (Amisia), and

the excellent geographical representation of the mountain-chains of Syria and Palestine[36]. Curtius [37] has left behind him a natural picture of a wooded wilderness, through which the Macedonian army, in its westward course from Hecatomphylos, in the marshy Mazenderan, was obliged to pass. I would have mentioned in detail this account, if we could have distinguished with accuracy the parts which the author (the date of whose writing is so uncertain) had drawn from historical sources, or those which his own lively fancy has supplied him with.

We shall consider presently, in the History of the World, the great general production of the elder Pliny, to which no other work of antiquity can be compared in respect of the richness of its contents. It is as his nephew, Pliny the younger, has remarked "manifold as Nature herself." The Natural History of the elder Pliny, although a proof of his irresistable inclination to a general and often careless collection of facts, though unequal in style, at one time simple and cautious, at another rich in thought, and adorned with oratory, is nevertheless, from its very form, barren in special delineations of Nature; but when he speaks of the grand and united action of the powers in the Universe upon the well-regulated world, (Kosmos: Naturæ Majestas), we cannot mistake the existence of real and original genius. This work has had a powerful effect on the whole of the middle ages.

As a proof of the natural feeling among the Romans, we would also willingly have brought forward the beautifully situated villas on the Pincius, by Tusculum and Tibur, or the Promontory of Misenum at Puteoli and

Baiæ, if these places had not been full of grand buildings, like those of Scaurus and Mecænas, Lucullus and Adrian. Temples, theatres, and race-courses, were mixed up with houses for birds and buildings intended for the breeding of snails and dormice. The elder Scipio had surrounded his otherwise simple country residence at Liturnum with towers like a fortress. The name of a friend of Augustus (Matius) has been preserved to us, because, in his love for stiffness and unnatural appearances, he first introduced the plan of cutting off the trees, in order to make them into patterns for architects and builders. The letters of the younger Pliny give us lively accounts of two of his numerous villas ([38]), Laurentinum and Tuscum. And, if in both of these habitations, surrounded by clipped box-trees, we find objects more crowded together than is usually in accordance with our taste; yet, these representations, as the imitations of the Valley of Tempe, in Adrian's Tiburtine Villa, show that a love for the free enjoyment of Nature was not foreign to the inhabitants of Roman towns; they had besides, a love for art, and a most anxious desire for comfort, in the choice of a situation for their country-houses, and paid great attention to the aspect and the prevailing winds. We may add to this with pleasure, that Pliny's enjoyment of his country possessions was not disturbed by the disagreeable sight of the misery of slaves. The rich man was not only one of the most learned of his times, but he had also, what in antiquity was at any rate seldom expressed, a pure human feeling of pity for the lower and slaving classes of mankind. In the houses of Pliny the younger there were no chains: the slave, as well

as the tiller of the soil, freely possessed and transferred the property which he had acquired (39).

No account of the eternal Alpine snows, glowing with the red colour of the morning or evening, of the blue glaciers, or of the grand nature of the Swiss scenery has descended to us from the ancient writers; and yet, in unbroken succession, statesmen, and commanders, and literary men in their train have passed through Helvetia to Gaul. All these travellers know only how to complain of the difficult and disagreeable roads, but they never busied themselves with the romantic scenery. It is, indeed, well known that Julius Cæsar, as he was returning to his legions in Gaul, employed the time, whilst they were passing the Alps, in preparing his grammatical work "De Analogia" (40). Silius Italicus, who died in the time of Trajan, at a period when Switzerland was already in a cultivated state, describes the region of the Alps as a horrid desert (41), without vegetation, whilst he joyfully celebrates all the rocky valleys in Italy, and the bushy shores of the Liris "Garigliano" (42). It is at the same time remarkable that the Romans, not only never describe, but never even mention the wonderful appearance of the broken basaltic pillars, as seen in such varied forms in the middle of France, on the banks of the Rhine and in Lombardy.

When the feelings which enlivened the ancient classic age, and directed the minds of men to the management of business, and the manifestation of human powers instead of to objects, and the contemplation of the external world, died away, a new mode of thinking arose. Christianity gradually spread itself, and as, except where it

appeared as a State Religion, it had a salutary influence upon the important matter of civil freedom of the human race, among the lower orders, so it gave them a more expanded view of the beauties of Nature. The eye was no longer fixed upon the Olympian gods; 'the Creator (for thus the Fathers of the Church teach in their accurate and frequently imaginative and poetical language) shows his greatness in inanimate and as in living Nature, in the wild strife of the elements, as in the silent direction of the development of organic structures. At the gradual dissolution of the Roman Empire, imaginative power, simplicity and purity of diction disappear from the writings of that melancholy time; they were first lost in the Latin countries, and afterwards in the Eastern part of Greece. Inclination for solitude and melancholy meditation, and depression of the feelings were apparent; it affected simultaneously the language and the colouring of their style.

When anything new in the mind of man appears to be at once developed, an early deeply-seated and isolated germ is generally discovered. The weakness of Mimnermus (43) has frequently been discovered to have been a sentimental direction of his mind. The ancient world was not abruptly separated from the modern, but changes in the religious ideas of mankind, in the tenderest feelings, and in the peculiar habits of those who exercise influence over the notions of the people generally, caused those subjects, which before attracted no attention, suddenly to predominate. It was one aim of the Christian spirit to prove the greatness and goodness of the Creator, from the order of the World and the beauties of Nature. This aim, the

glorification of the Godhead by the contemplation of his works, gave rise to a taste for the description of natural scenes. The earliest and fullest examples are found in a cotemporary of Tertullian and Philostratus, in the writings of an eloquent lawyer at Rome, Minucius Felix, at the commencement of the third century. We trace him willingly in the twilight wandering upon the shore at Ostia, which he describes as more beautiful and more conducive to health, than it is even considered to be at present. In the religious dialect of Octavius the new belief is courageously defended against the objections of a heathen friend (44).

This is the place to bring forward some fragments of the descriptions of Nature from the Fathers of the Grecian Church, as they are probably less known to my readers than those which are expressive of the moral habits of ancient Italy, and have been handed down to us in the Roman literature. I begin with a letter of Basil the Great, for whom I have for a long time cherished a profound admiration. Born in Cesaræa in Cappadocia, Basil, when not much more than thirty years old, had renounced a happy life at Athens, and had already visited the Christian hermitages in Cœlesyria and Upper Egypt, and had withdrawn himself into a wilderness upon the banks of the Armenian River, Iris. There his second brother (45), Naucratius, after fifty years of a strict anchorite's life, was drowned whilst fishing. "I believe," says he, in a letter to Gregory Nazianzen, "that I have at last arrived at the end of my wanderings. The hope of joining myself to you, I may say, my sweet dreams (for truly indeed are hopes the dreams of waking men) have remained unfulfilled. God has permitted me to find a place

such as He has often presented to our imaginations. That which was shewn to us in the distance, I see immediately before me. A high hill covered with thick wood is upon the north watered by fresh flowing springs. At the foot of the hill a broad plain stretches out, rendered fertile by the mists which envelop it. The surrounding wood, in which various trees are collected together, incloses me as in a strong tower. The desert is bordered by two deep and rocky valleys: upon one side the river, where it foams and dashes down from the hill, forms an almost impassable barrier; upon the other a broad mountain ridge shuts up the entrance. My hut is so situated upon the summit that I can overlook the distant plain, as well as the whole course of the Iris, which is more beautiful than the Strymon of Amphipolis. The river of my desert, more charming than any other which I know, rushes against a projecting rock and dashes and foams against the precipice, a spectacle full of attraction and wonder to the wanderer upon the mountains, and useful to the natives by its plentiful supply of fish. Shall I describe the fertilizing vapours which rise up from the moist earth, and the cool breezes which are wafted from the rippling surface of the water? Shall I speak to you of the lovely song of the birds, and the fulness of the blossoming flowers? That which charms me beyond everything, is the quiet stillness of the region. It is sometimes only visited by hunters; for my wilderness produces deer and herds of wild goats, and not your bears and your wolves. How could I change this for any other place? Alcmæon having found the Echinades would wander away no further (46)." In this simple delineation of scenery, and

of life in the desert, feelings are expressed more in accordance with those of modern times than anything that has been handed down to us from Grecian or Roman antiquity. From the lonely mountain hut into which St. Basil withdrew himself, the eye falls upon the humid foliage of the trees in the wood beneath. The resting-place which he and his friend Gregory Nazianzen (47) had so long desired, is at last attained. The poetical and fanciful remark at the end of his letter sounds like a voice, which, from a former world, echoes in Christian times.

Basil's Homilies about the Hexa-emeron bear witness of his natural feelings. He describes the mildness of the pleasant nights in Asia Minor, where, as he expresses himself, the stars, "the eternal blossoms of heaven," raise up the spirit of man from what is visible to the Invisible (48). When in the tradition concerning the Creation of the World, he praises the beauty of the sea, he describes the sight of the boundless surface, with its various and ever-changing appearances, "how, softly moved by the breath of the wind, of various colours, white, blue, or reflecting the red light of the sky, it caresses the shore in its innocent play." The same melancholy and sentimental expressions in praise of natural scenery are used by Gregory of Nyssa, the brother of Basil the Great. "When," says he, "I see every mountain ridge, and every valley and plain covered with fresh verdure, and then look upon the manifold ornaments of the trees, and at my feet find the lily, doubly enriched by nature, with a sweet odour and with beautiful colours, when in the distance I view the sea to which the clouds take their flight, my soul is filled with

delightful melancholy. Then in autumn the fruits disappear, and the leaves fall, the branches of the trees are robbed of their ornaments, and are benumbed; and with this eternal and regularly recurring change, we are overwhelmed by the wonderful power and harmony of Nature. He who looks at these things with the eye of the soul, feels the littleness of Man in the greatness of the Universe" (49).

If the glorifying of God in the admiration of the beauties of Nature, leads the Christian Greeks to poetical descriptions of scenery; they were also in the earlier times of the new belief, from the peculiarity of their perceptions, full of contempt for the works of human art. St. Chrysostom very frequently says, "when you see the glittering houses, and feel inclined to admire the rows of pillars, examine at once the vault of the sky and the green fields, where the herds are feeding upon the shores of the sea. Who does not despise the productions of art, when in the stillness of the early morning he admires from his heart the rising sun pouring its golden light over the world? When resting near a fountain in the deep grass, or under the darkening shadows of the thickly-leaved trees, his eyes wander over the dim and distant prospect?" (50) Antioch was then surrounded by hermitages, and in one of them St. Chrysostom lived. It seems as if natural eloquence, in the woody mountainous regions of Syria and Asia Minor, had regained its element "Freedom."

But when in later times, so hostile to all mental culture, Christianity spread itself among the German and Celtic races, who before this were followers of Nature,

and adored her preserving and destroying power in naked symbols; a close acquaintance with Nature's works, and the investigation of her powers were looked upon with suspicion, as tending towards witchcraft. This knowledge seemed to them as fraught with danger, as attention to matters of art, did to Tertullian and Clement of Alexandria, and nearly all the ancient Fathers of the Church. In the twelfth and thirteenth centuries, an assembly of the Church at Tours (1163), and at Paris (in 1209), prohibited the monks from reading works upon physics, as sinful (51). By Albert the Great, and by Roger Bacon, the chains which bound down the minds of men were courageously broken; Nature received absolution, and was restored to her ancient rights.

We have hitherto shewn the contrast, which in the different epochs, is so manifest in the closely allied productions of the Grecians and Romans. This contrast in their natural feelings is not caused by time alone; that is, by the events in the world which incessantly change the form of their government, their manners and religious feelings; but more strikingly by those occurrences, which prove the original differences in their races and in their natural capacities. How completely different is the liveliness of the natural feelings and the poetical colouring of the descriptions of scenery in the Grecians, the Northern Germans, the Semitic races, the Persians and the Indians! It is an opinion which has been frequently expressed, that in northern tribes of men, the delight in the beauties of Nature, and a long-standing desire after the attractive scenes in Italy and Greece, and for the wonderful luxuriance of tropical vegetation, is chiefly to

be attributed to the absence of all natural enjoyments which they experience during their long winter season. It is not to be denied that this longing after a tropical climate decreases as soon as we come down to the south of France, or the peninsula of Spain; but the people of the Indo-Germanic races (whose name is so accurate in an ethnological sense, and now so commonly used) should remember that too general an effect must not be attributed to the influence of a northern winter.

The very rich poetical literature of the Indians teaches us that between and near the tropics, and south of the Himalaya chain, evergreen and blooming woods have excited in a lively way the imagination of the East-Arian people, so that they are more inclined to a poetical description of natural scenes, than the genuine German races, who are spread over the inhospitable north, as far as Iceland. An absence, or at least a certain interruption to the enjoyment of Nature, is peculiar even to the happy climates of the south of Asia. The seasons are abruptly separated from one another, by the change from the fertilizing rain to the dusty and consuming drought. In Persia (the West-Arian table-lands) the barren wilderness extends in the form of bays into the most fertile and fruitful surrounding country. In the middle and more distant regions of Asia, thick woods clothe the shores of an extensive inland lake. Thus the relative condition of the soil in various parts, and in a horizontal direction, affords to the inhabitant of this hot climate the same contrast of desert and fertility, as is seen in a perpendicular direction in the snow-clad mountain chains of India and Affghanistan. Grandeur in the scenery and

contrast in the seasons, in the vegetation and the forms of the mountains, are the exciting element of poetic imagination, wherever a lively feeling for the beauties of Nature is interwoven with the whole culture, and the religious disposition of a people.

Love for Nature, so peculiar to the contemplative bent of the German nations, is to the greatest degree apparent in the earliest poems of the middle Ages.

The gallant poetry of the love-songs in the age of chivalry gives many proofs of this. Poetry of this nature has many historical points of contact with that of the romances of Provence, but still its real German spirit has never been mistaken. An internal and all-pervading natural feeling shines forth from the customs, and from all the habits of life among the Germans, even from their longing desire after freedom ([52]). The wandering minstrels, living much in the circle of courts and even originating in them sometimes, were nevertheless in continual intercourse with Nature. They retained a pastoral, and often soft and sentimental disposition of mind. In order to be able to value the productions of this natural disposition, I turn to the inquiries of those who are most intimately acquainted with the literature of our German middle Ages, to my noble friends, Jacob and William Grimm.

"The poets of our native country, in those epochs," says the latter, "have nowhere given themselves up to a special delineation of Nature, or to the composition of a work which has no other aim, than to represent in lively colours, the impression of the landscape upon the mind. A sense for the beauties of Nature, is certainly not want-

ing in the old German masters, but they have left behind them no other proof of this sense, than such as their connection with historical events and with mental emotions has permitted them to embody in their lyric poems. To begin with the popular epic verses, the oldest and most valuable memorial of those times, we do not find in the 'Nibelungen,' nor in the 'Gudrun,' (53) the description of any natural scene, even when there is occasion for it. In the otherwise circumstantial account of the hunt, in which Siegfried was murdered, the flowering forest and the cool fountains under the lime-trees, are merely mentioned. In the 'Gudrun,' which certainly shows a finer imaginative power, a sense for the beauties of Nature is somewhat more apparent. As the King's daughter, with her companions in a forced and humiliating state of slavery, was carrying the garments of her cruel lord to the sea-shore, the time of the year is denoted, when the winter has just terminated, and the rival chorus of the birds begins. Rain and snow are still descending, and the flock of maidens are nipped by the raw March winds. As Gudrun, expecting her liberator, leaves her couch, and the sea begins to glitter with the rising of the morning star, she distinguishes the dark helmets and the shields of her friends. They are but few words in which this is described, but they give a lively picture, intended to increase the expectation of the reader, before the occurrence of some important event. In the same way, Homer writes when he is describing the Island of the Cyclops, and the well-arranged gardens of Alsinous; he represents the luxuriant foliage of the forest, in which the gigantic monsters live, and the splendid dwelling of a powerful

King. Neither of these poets enter upon the subject in order to give an independent account of natural scenery."

"The rich and full narrations of the chivalric poets of the thirteenth century are opposed to the smooth popular epic poems; they required a greater degree of art, and by means of them Hartmann of Au, and Wolfram of Eschenbach, and Gottfried of Strasburg, (54) in the beginning of the century rendered themselves so very prominent, that they have been called the great and classic writers. From their comprehensive works we could easily collect sufficient proofs of deep feeling for Nature's beauties, especially when they break out into figurative representations, but ideas of independent natural descriptions were unknown to them. They did not stop the progress of their occupations, in order to contemplate the picture of a quiet natural life. How different from this are the more recent poetical compositions! Bernardin de St. Pierre uses incidents only as a frame for his pictures. The lyric poets of the thirteenth century, especially when they sing of love, (for love is not always their subject), frequently speak of the mild May, the song of the nightingale, and the dew which glitters upon the flowers of the heath, but always in relation to the feelings which are reflected from them. In order to represent melancholy sentiments, he thinks of the yellow leaves, the silent birds, and the seeds buried beneath the snow. These thoughts, very well and very differently expressed, recur incessantly in his writings. The sensitive Walther, and the deep-thinking Wolfram of Eschenbach, of whose works we only possess some few lyric songs, may be here brought forward as excellent examples."

"The question whether contact with Southern Italy, or the Crusades in Asia Minor, Syria and Palestine, have not enriched the art of poetry in Germany with new natural pictures, can only generally be answered in the negative. It is not remarked that the acquaintance with the East gave any new direction to the songs of the minstrels. The Crusaders came little into actual contact with the Saracens; they even lived in a state of great restraint with other nations who fought in the same cause. One of the oldest lyric poets, was Friedrich of Hausen. He perished in the army of Barbarossa. His songs contain many views of the Crusades, but they chiefly express religious sentiments, or the pain at being separated from his dear friends. He found no occasion to say anything concerning the country, or any of those who took part in the wars, as Reinmar the Elder, Rubin Neidhart, and Ulrich of Lichtenstein. Reinmar came a pilgrim to Syria, as it appears, in the train of Leopold VI. Duke of Austria. He complains that the recollection of his country always haunted him, and drew away his thoughts from God. The date-tree has here been mentioned sometimes, when they speak of the palm branches which pious pilgrims bore upon their shoulders. I do not remember that the splendid scenery in Italy has excited the fancy of the Minstrels who crossed the Alps. Walther, who had wandered about, had only seen the river Po; but Friedrich was (55) at Rome. He merely remarked that grass grew in the palaces of those who formerly bore sway there."

The German epic poems upon the subject of animals, which must not be mistaken for the fables of the East,

have arisen from continual contact with the lower animals, without any intention of describing them. These poems, which Jacob Grimm treated in so masterly a way, in the introduction to his edition of "Reinhart Fuchs," indicate a deep love for Nature. The beasts of the field, which are not confined to one spot, which are provided with voices, and which are subject to the excitement of their passions, are contrasted with the quiet life of the silent plants. They are the ever-active living element in the landscape. Ancient poetry willingly contemplates the life of Nature, as with a human eye, and grants to animals and sometimes even to plants, the sense and feelings of man; it knows how to express, in a fanciful and simple way, every variety of form and instinct. Shrubs and flowers are plucked and used by heroes and gods, and thence obtain their names. It seems as if the ancient spirit of the German epic poems was wafted to us (56).

Among the memorials of the German natural poetry, we might formerly have been inclined to include some remnants of the Celtic and Irish poetry, which, for half a century wandered from one people to another, like an apparition, under the name of Ossian; but the deception has disappeared since the literary undertaking of the talented MacPherson was completely discovered, by the publication of the original text (a re-translation of the English work), from which he had forged his poem. There are old Irish Fingal songs, known in Christian countries by the name of "Finnian Songs," perhaps not reaching even as far as the eighth century; but these popular songs contain little of the sentimental delineation of Nature,

which gave to the poems of MacPherson so great a charm (57).

We have above remarked, that if sentimental and romantic exaltation of the feelings is, in a high degree, peculiar to the Indo-Germanic races of the north of Europe, we cannot consider the phenomenon, only as the consequence of the climate, that is, as a result of desire increased by long privation. We have remarked how Indian and Persian literature, developed under the glow of a southern sky, presents the most attractive delineations of organic, as well as of inorganic Nature, of the change from drought to tropical rains, and of the appearance of the first cloud in the deep clear blue atmosphere, when the long-wished-for Etesian winds began gradually to rustle in the feathery leaves of the summit of the palm-trees.

We will here enter more deeply into the field of Indian poetry. "If we imagine," says Lassen in his splendid work upon Indian Antiquity(58); "a part of the Arian race wandering from its original settlement to the land of the north-west, towards India, it would there be surrounded by an entirely new and wonderfully rich scenery. The mildness of the climate, the fertility of the soil, and the beautiful store of magnificent gifts must communicate a cheerful colouring to their new life. With the original great talents of the Arian people, in the possession of a higher mental endowment, in which everything elevated and great that has been exported from India, is rooted as a germ, the examination of the external world produced a deep reflection upon the

powers of Nature, a reflection which is the groundwork of that contemplative spirit so interwoven with the oldest poems of the Indians. So general an impression which Nature makes upon the minds of the people, shows most clearly its influence in their religious views, and in their acquaintance with what is divine in Nature. The careless ease of their external existence came to the aid of these meditations. Who could give himself up more completely and undisturbedly to muse upon our earthly existence, the condition of Man after death and the attributes of the Divinity, than the Indian penitent, the Brahmin ([59]), the inhabitant of the forests, whose ancient school forms one of the most peculiar phenomena of Indian life, and exercised so decided an influence upon the mental development of the whole race ?"

If, as I have done in my public lectures, under the direction of my brother and others, learned in Sanscrit literature, I enter into particulars of the spirit, which a lively and frequently excessive natural feeling has interwoven in the descriptive parts of the Indian poetry, I must begin with the Vedas, the first and most sacred memorial of the culture of the East-Arian people. The chief subject is the adoration of Nature. Charming descriptions of the morning sky, and the aspect of the "golden handed" sun are contained in the Rigveda. The great heroic poems, Ramayana and Mahabharata, are more recent than the Vedas, but older than the Puranian histories. In the creation of their fancy, the glorifying of Nature is closely united to their traditions. Although in the Vedas the actual scenes which the holy wise beings inhabited are seldom indicated; yet in the heroic poems,

the delineations of Nature are mostly special, and connected with certain localities, and have more life in them, for they were made from personal impressions. The journey of Rama of Ayodhya to the city of residence of Dschnaka, his life in the wood, and the picture of the hermit life of the Pandavas are painted in rich colours.

The name of Kalidasa has been frequently and early celebrated among the western nations. The great poet flourished at the splendid court of Vikramaditya, and was, therefore, cotemporary with Virgil and Horace. The English and German translations of the Sakuntala have excited the feeling of admiration which has been so amply bestowed upon Kalidasa(60). Tenderness in the expression of feelings, and richness of creative fancy, have assigned to him his lofty place amongst the poets of all nations. The lovely drama of Vikrama and Urvasi, where the King wanders about in the thick forests in search of the nymph Urvasi, and the poems of the Seasons, and the "Messenger of the Clouds" (Meghaduta), are proofs of the beauty of his natural descriptions. In this poem the joy, with which the first appearance of a rising cloud is greeted, as an indication of the approaching rainy season, after the long tropical period of drought, is represented in language wonderfully true to nature. The expression, "true to nature," which I have just made use of, can alone justify my boldness in comparing with the Indian "Messenger of the Clouds," a natural picture of the commencement of the rainy season(61), which I sketched in South America, at a time when I was neither acquainted with the "Meghaduta" of Kalidasa, or even with Chezy's

translation. The mysterious meteorological processes which take place in the atmosphere, in the formation of vapour; the forms of the clouds, and the appearance of electric lights, are the same between the tropics upon both continents; and the imaginative faculty, whose duty it is to elevate reality to a picture, would lose none of its mysterious charm, if it was the good fortune of an investigating and observant spirit, in after-centuries, to confirm the natural truth of an ancient and merely contemplative poem.

We pass from the Eastern-Arians, and the Indian Brahmins, with the decided aim of their perceptive powers towards the picturesque beauties of Nature(62), to the Western-Arians and the Persians, who had separated in the northern Zendish country, and were originally attached to a spiritual adoration of Nature, as well as to the two-fold doctrine of Ahriman and Ormuzd. That which we call Persian literature only ascends as far as the time of the Sassanides; the most ancient memorials of their poetry have perished. After the land had been subjugated by the Arabians, and they had become estranged to it, it again attained a national literature under the Samanidæ, the Gaznevides and the Seldshuks. The flower of their poetry lasted scarcely four or five hundred years, from the time of Firdusi to Hafiz and Dschami; it only extends up to the voyage of Vasco de Gama. If we trace the natural feeling of the Indians and Persians, we must not forget that both nations, viewed in reference to the amount of their cultivation, appear to be distinct from one another, as well with regard to time as space. The Persian literature belongs to the middle ages,

the great Indian writings belong peculiarly to antiquity. The scenery of the Iranian Highlands has not the luxuriance of the growth of trees, and the wonderful variety in the form and colour of plants, which adorn the land of Hindustan. The Vindhya chain of mountains, so long the boundary of the East-Arian people, is within the tropics, whilst all Persia lies outside; indeed the Persian poetry partly belongs to the northern country of Balkh and Fergana. The four Gardens of Paradise (63), celebrated by the Persian poets were, the beautiful valley of Soghd at Samarkand, Mashanrud at Hamadan, Scha'abi Bowan at Kal'eh Sofid in Fars, and Ghute the plain of Damascus. Both Iran and Turan are deficient in forest scenery and the hermit life in the woods, each of which has so powerfully influenced the imagination of the Indian poets. Gardens enlivened with fountains, and filled with rose-trees and fruit, do not replace the wild grandeur of the scenery of Hindustan. No wonder then that the descriptive poetry is less fresh, and often jejune, and that it has less life, and more artificial elegance. If, according to the idea of a native writer, we give the highest praise to that which we indicate by the words "spirit" and "wit," our admiration must confine itself to the fertility of the Persian poets, and to the unbounded variety of the forms (64) under which they are able to treat the same subject; depth and fervour in their thoughts and feelings are absent.

The description of the landscape, too, but seldom interrupts the narrative in their national epic poems, or the historical book of the heroes of Firdusi. The praises of the shores of Mazenderan in the mouth of a wandering

singer, appear to me to be especially attractive, and possessed of local truth, in the description of the mildness of the climate, and the power of vegetation. The King Kei Kawes, by means of these laudatory verses, was incited to a march to the Caspian Sea, and to a new conquest(65). The poems of Enweri, Dschelaleddin Rumi, Adhad and the half Indian Feisi (the second is considered the greatest mythical poet of the East) in praise of spring, breathe a fresh life, and in them the attempt at figurative representations, is not an unpleasant interruption to our enjoyment in this work. (66) Sadi in Vostan and Gulistan (the garden of fruits and roses), and Hafiz, whose cheerful philosophy of life has been compared with that of Horace, point out how Joseph von Hammer expresses himself in his great work upon the History of Persian poetry; the former belonging to an age of moral philosophy, the latter being a minstrel of the highest forms of lyric verse; but bombast and affectation frequently take the place of natural description. (67) The favourite subjects of Persian poetry, "the loves of the nightingale and the rose," recur in a wearisome manner; and the real internal feeling for the beauties of nature, degenerates in the East into the conventional artifices of the "language of flowers."

If we pass from the Iranian heights through Turan, in Zend Tuirja (68), northwards into the Ural mountains which separate Europe from Asia, we come to the original birth-place of the Finnish race; for Ural is an ancient Finnish, as Altai is an ancient Turkish country. Among the Finnish races at the present day, who are settled far in the West and upon European ground, Elias Lönnrot

has collected a large number of Finnish country songs, from the mouths of singers and country people, in which, according to the expression of Jacob Grimm (69), "a lively feeling for Nature is apparent, such as is almost solely met with in Indian poetry." An old epic poem, of nearly three thousand verses, describes the battle between the Finns and the Lapps, and the fate of a divine hero who was called Vaino. This poem contains a lively account of the manners of the country life, especially where the wife of the smith, Ilmarinen, sends her herds into the woods and prays for the protection of her cattle. But few nations, which have been influenced by degenerating servitude, by the horrors of war, or by continual struggles for political freedom, present in their mental formation, and in the direction of their feelings, more wonderful and manifold gradations, than the Finnish race in the grammatical subdivisions of its language. We are here reminded of the people, so quiet at the present time, among whom the poem was found: viz., of the Huns, the disturbers of the peace of the world, so long confounded with the Mongolians, and also of the great and noble people, the Magyars.

After our consideration of the liveliness of the natural feelings and the form of their expressions, apparently dependant upon the difference of the races, the peculiar influence of the scenery, the political constitution, and their religious creed; it remains for us to take a view of the people of Asia who most of all contrast with the Arian, or Indo-Germanic races of the Indians and Persians. The Semitic or Aramæic nations, in the oldest and most perfect specimens of their poetical genius and

creative fancy, show indications of deep natural feeling. The expression of their thoughts is manifested in a grand and lively way in the traditions of the shepherds, in the songs of the Temple, in the choruses, in the beauty of the lyric poems in the time of David, and in the school of Seers and Prophets, whose high inspiration is almost estranged from the past and directed towards the future.

The Hebrew style of poetry, with its deep and elevated grandeur, affords to the inhabitants of the East, the still more peculiar charm, that it is very much interwoven with the local associations of the believers in the three most widely spread religions, the Mosaic, the Christian, and the Mahommedan. By means of missions, which are favoured by commercial enterprise and the desire of conquest in maritime nations, the geographical names and natural descriptions of the East, as they are preserved in Books of the Old Testament, have penetrated into the deep forest of the New World, and into the Islands of the South Sea.

It is a characteristic sign of the natural poetry of the Hebrews, that, as the effect of Monotheism, it includes the whole universe in a single unit: both the life upon earth and the glittering expanse of heaven. It dwells but little upon individual phenomena, but rejoices in the contemplation of greatness. Nature is not represented as something independent, to be glorified for her own beauty. In the writings of the Hebrews, it appears always in relation with a high and powerful spirit. They describe Nature as something created and arranged, the living expression of the omnipresence of God in the works of this world of sense. Therefore, the lyric poetry of the

Hebrews is grand in its contents, and possessed of a solemn earnestness: it is melancholy and full of sadness when it touches upon the earthly condition of mankind. It is also worthy of remark, that this poetry, in spite of its grandeur and origin, the high degree of its inspiration, and the charming effect of music, is never arranged in measure, like the Indian verses. Devoted to pure contemplation of the Divinity, skilfully arranged in its diction, but simple in thought, it delights in similitudes, which continually recur, almost in a rhythmical manner. In its natural descriptions, the writings of the Old Testament are a true reflection of the peculiarities of the country in which the people lived, and of the many changes, from the state of a desert, to fertility, and to the wooded regions of Libanus which are found in the land of Palestine. They represent the relation of the climate in its regular seasons, the manners of the shepherds, and their hereditary disinclination to agriculture. The epic, or historical accounts, are of extreme simplicity, almost more devoid of ornament than those of Herodotus. They are true to Nature, as the most recent travellers unanimously declare; so little is the change in the habits and the various relations of a shepherd's life. The lyric poems of the Hebrews are more ornamented, and contain a richer view of the life of Nature. We might say that a picture of the whole of "Kosmos" is represented in the 104th Psalm:—"Thou deckest thyself with light as it were with a garment, and spreadest out the heavens like a curtain. He laid the foundations of the earth that it should never move at any time. The waters go up as high as the hills, and down

to the valleys beneath, even unto the place which Thou hast appointed for them. Thou hast set them their bounds which they shall not pass, and all the beasts of the field shall quench their thirst. The birds of the air sing among the branches. The trees of the Lord are full of sap, so are the cedars of Libanus which He hath planted, wherein the birds make their nests, and the fir-trees are a dwelling for the stork." The heavenly bodies give the finishing touch to this natural picture. "The Lord appointed the moon for certain seasons, the sun knoweth his going down. Thou makest darkness that it may be night, wherein all the beasts of the forest do move. The sun ariseth and they get them away together, and lay them down in their dens. Man goeth forth to his work and to his labour until the evening." In a lyric poem of so small a compass we are surprised to find the universe, the heaven and the earth represented with a few grand touches. The quiet and careful occupation of Man, from the rising of the sun till the end of his day's work in the evening, is here contrasted with the moving life of the elements in Nature. This contrast and this general apprehension of the recurrent natural phenomena, and this retrospect upon the All-present Invisible Power, which can renovate the earth or crumble it into dust, gave to this poetry not so much a warm and lively nature, as the solemnity of an elevated composition.

Similar views of the Creation occur in many other parts (70) (Psalm 65, v. 7—14 and 74, v. 15—17;) but perhaps most to perfection in the 37th chapter of the ancient Book of Job, the date of which is possibly even

before Moses. The meteorological processes which take place in the clouds, their formation of various figures, and the dissolution of the vapour, in different directions of the wind, their colour, and the production of hail and of the rolling thunder, are represented with peculiar precision; and many questions are proposed which the physical philosophy of the present day is able to express in a scientific formula, but which we cannot solve in a satisfactory way. The Book of Job is in general looked upon as the most perfect production which Hebrew poetry has brought forth. It is as artistic in the exhibition of individual appearances, as it is skilful in the arrangement of the entire didactic composition. In all modern languages, into which the Book of Job has been translated, its natural representations of the East leave a deep impression upon the mind. "The Lord walks upon the heights of the sea, upon the summit of the waves lifted up by the storm. The redness of the morning touches the edges of the earth, and gives various forms to the clouds, like the clay moulded in the hand of a man." The habits of animals are delineated: the wild ass and the horse, the buffalo, the hippopotamus, and the crocodile, the eagle and the ostrich. We see "the pure ether, expanded over the burnt wilderness, in the sultry south winds, like molten glass (71)." Where Nature sparingly gives her bounties, she sharpens the senses of man, so that he listens for every change in the wind's quarter, and examines the flight of the clouds, that in the loneliness of the desert, as of the stormy ocean, he may investigate every changing occurrence, and trace their succession. The climate in the barren and rocky parts of Palestine is

especially calculated to excite such observations. Nor is the poetic literature of the Hebrews deficient in variety of forms. Whilst from Joshua to Samuel, the poetry breathed a warlike spirit, the little Book of Ruth, and the account of her gleaning, presents the most complete simplicity and inexpressible beauty. Göthe (72), in the age of his enthusiasm for the East, calls it "the loveliest epic and pastoral composition which has been handed down to us."

Even in more recent times, in the first specimens of the literature of the Arabians, we remark a weak reflection of the grand view of Nature, which was at so early an age peculiar to the Semitic race. I remember the artistic delineation of the Bedouin life in the wilderness, which the grammarian Asmai connects with the great name of Antar, and has united with some other traditions of chivalric deeds (before the time of Mohammed), into a single great work. The chief personage in these romantic novels is the same Antar, of the race of Abs, the son of the chief nobleman Scheddad and of a black slave. These verses are preserved among the prize poems (Moallakât) in the Kaaba. The learned English translator, Terrick Hamilton, has drawn attention to the beautiful harmony of the style in Antar (73). Asmai makes the son of the wilderness travel to Constantinople, by which a lively contrast between Grecian cultivation and the rudeness of the Nomada is introduced. According to the remarks of a distinguished judge of this branch of literature, my friend Freytag of Bonn, we cannot wonder that, in the earliest poetry of the Arabians, delineations of natural scenery have taken so small a space, because the chief contents of

the poem are narratives of deeds of arms, and the praise of hospitality and of love, and because scarcely any of the singers actually sprung from Arabia Felix. The melancholy uniformity of grassy plains and sandy deserts can only excite a love for Nature in certain very rare dispositions.

Where the ornament of forests is wanting, as we have previously remarked, the phenomena of the atmosphere, storms, thunder, and the long-wished for rains, occupy so much the more the imagination of the writers. I here remember particularly (if I may borrow the beautiful pictures of this kind from the Arabian poets) Antar's "Moallakât," which describes the plains fertilized by the rain, and visited by swarms of humming insects (74); the splendid and local descriptions of the thunder in Amru'l Kais, and in the seventh book of the famous Hamasa (75); and lastly, the swelling of the river Euphrates, as the trunks of trees and reeds float down its stream, in the "Nabegha Dhobyani (76)." To the eighth book of Hamasa, which is entitled "Journeys and Sleepiness," my particular attention has naturally been directed. I soon discovered that the "Sleepiness (77)" only occupies the first portion of the book, and is so much the more excusable, that it is to be attributed to a night journey upon a camel.

In the foregoing section, I have attempted to show how the external world, that is, the contemplation of animate and inanimate Nature, at different epochs and in different races of mankind, has produced various and unequal effects upon the world of thoughts and perception. We have taken from the history of literature all that charac-

terized the lively expression of the natural feelings. In this way we have aimed, as in my entire work on "Kosmos," not at a perfect, but a general view; I have chosen those examples, in which the peculiarities of the times and races of men are clearly seen, and I have brought forward specimens of the Greek and Roman literature, up to the time of the gradual decline of those feelings which gave to classical antiquity in the West, its inextinguishable lustre. I have traced the beautiful expression of the taste for Nature's beauties in the writings of the Fathers of the Christian Church, which the hermit's life in their quiet resting places, produced. In our examination of the Indo-Germanic people (I use the term here in its strictest sense), we passed from the poems of the Germans in the middle ages, to those of the highly cultivated ancient East-Arians (Indians), and the less gifted West-Arians, the inhabitants of ancient Iran. After a hasty glance at the Celtic song, and a newly discovered Finnish epic poem, I described the rich natural life which breathes in a branch of the Semitic Aramæic) race, and in the exalted poems of the Hebrews and Arabians. Thus we have seen the world of phenomena reflected in the imagination of the people in the North and South East of Europe, in Asia and in the Persian table-lands, and in the Indian tropical countries. In order to include Nature in her entire grandeur, I have thought that I must consider her in two aspects: the first objective, including her active phenomena, and afterwards, as she is reflected in the mind of man.

After the disappearance of the Aramæic, Grecian and

Roman powers, I might say, after the ancient world had passed away, the great and spirited poet of the modern world, Dante Alighieri, shows us from time to time the deepest feelings for nature. He sometimes withdraws himself from the emotions of a deep and mysterious doctrine, which forms the wide subject of the circle of his ideas. The time at which he lived, followed immediately upon that in which the Swabian minstrelsy, that we have so often mentioned, began to echo on this side the Alps. Dante pictures the morning breeze, and the trembling light of the gently moving sea " il tremolar de la marina," in an inimitable manner at the end of the first canto of the Purgatorio (78); in the fifth canto, he represents the bursting of the clouds, and the swelling of the rivers, and how after the battle of Campadino, the corpse of Buonconte de Montefeltro sank in the Arno (79). The entrance into the thick grove of the earthly paradise, reminds the poet of the pine forest at Ravenna, " la pineta in sul lito di Chiassi" (80), where the early songs of the birds sounded from the summits of the trees. With the local truth of this picture, he contrasts the stream of light in the heavenly Paradise, from which sparks (81) are scattered " which sink into the flowers on the banks, but as if intoxicated with the sweet odours are again immersed in the stream, whilst others rise up." We might believe that this fiction originated from the recollection of the peculiar and rare condition of the phosphorescence of the ocean, in which glittering sparks appear to raise themselves over the surface, from the dashing of the waves, so that the entire expanse of water appears like a moving sea of stars. The extraor-

dinary conciseness of the style in the "Divina Commedia" increases the earnestness and depth of the impression.

To remain still upon Italian grounds, but avoiding the cold songs of the shepherds, I here name after Dante, the dirge of Petrarch, representing the impression which the lively valley of Vaucluse had made upon him after Laura's death; and the smaller poems of Boyardo, the friend of Hercules of Este, and the later stanzas of Vittoria Colonna (82).

Now, when classical literature began to flourish again more generally, from suddenly increased traffic with Greece, which had sunk so low in a political point of view; we find the first example of delightful description of scenery among the prose writers, in the works of the tasteful Cardinal Bembo, the adviser and friend of Raphael. The little production of his youth, the dialogue "Etna," gives us a lively picture of the geographical distribution of the plants, in the neighbourhood of the mountain, from the rich and fertile plains of Sicily, to the snow-covered edges of the crater. The perfect work of his mature age, the History of Venice, is characterized by a still more artistic representation of the climate and the vegetation of the New World.

All was at that time well adapted to satisfy the minds of men with delineations of the recently enlarged boundaries of the known world, and with the exaltation of human power. As in ancient times the Macedonian campaign to Paropamisus, and the wooded valleys and rivers of India, by the sight of a richly ornamented foreign country, left behind it impressions which were

clearly manifest in after-centuries, in the works of highly gifted authors; so the discovery of America had a second time, and in a higher degree than the Crusades, a similar effect upon the nations of the West. The tropical world, with the luxuriance of vegetation in the plains, with all the gradations in organic life in the neighbourhood of the Cordilleras, and with all the peculiarities of a northern climate in the inhabited heights of Mexico, New Granada, and Quito, was now for the first time opened to the contemplation of Europeans. Imagination, without which no truly great work of man can thrive, gave a peculiar charm to the natural delineations of Columbus and Vespucci. A close acquaintance with the poets of ancient and modern times characterizes the description of the Brazilian coast, in the works of the latter; an earnest religious disposition is found in the accounts of the mild climate of Paria, and of the vast tide of the Orinoco, streaming through the eastern Paradise (as he terms it), which have been handed down to us by the former traveller. By increasing age and by struggles against unjust persecution, this disposition degenerated into a state of melancholy and fanaticism.

In the heroic times of the Portuguese and Castilian races, not only avarice (as ignorance of the condition of the people at that time has led many to suppose), but a general taste for the perils of distant voyages guided their steps. The names of Haiti, Cubagua, and Darien in the beginning of the sixteenth century affected the imaginations of mankind, as in more modern times, since Anson and Cook, those of Tinian and Otahaite have done. If at that time an acquaintance with distant lands enticed the

youth from the Spanish peninsula, from Flanders, Milan and the south of Germany, to march under the victorious flag of the great Emperor to the summits of the chain of the Andes, or the burning plains of Uraba and Coro; the milder influence of the manners of later times, and the simultaneous discovery of many parts of the earth gave another motive, and another direction to the restless desire for foreign regions. A passionate love for the study of Nature, originating chiefly from the north, stimulated the minds of men. An increased sphere of intellect was accompanied by a considerable extension of scientific attainments, and the poetical and sentimental humour of the age, characterized itself at the end of the century, by the production of literary works in a style unknown to former periods.

If we cast a look backwards to the time of the great discoveries which paved the way for this modern disposition, we must consider in the first place the delineations of Nature which we possess, from the hand of Columbus himself. We have been but a short time acquainted with the Journal of his Voyages, his letters to the treasurer, Sanchez, to the nurse of the Infanta Don Juan, Madame Juana de la Torre, and to Queen Isabella. I have already in another place, in my "Critical Investigations concerning the History of the Geography of the fifteenth and sixteenth centuries (83)," attempted to show with what deep natural feeling this great discoverer was endowed; how he described the world and the new sky which were opened to his view, with a beauty and simplicity, which those alone can appreciate, who are acquainted with the ancient power of the language of that time "viage nuevo al

nuevo cielo i mundo que fasta entonces estaba en occulto."

The characteristic forms of the plants, the impenetrable thickness of the woods, "in which one can scarcely distinguish to what stems, the leaves and blossoms belong," the wild luxuriance of their soil, covered with verdure upon the humid shore, and the rose-coloured flamingos, which in early morning enliven the scene by fishing in the mouths of the rivers, employ the pen of the ancient sailor, as he was coasting along the shore of Cuba, between the little Lucayan Islands and the Jardinillos, a place which I also have visited. Every newly discovered country seemed to him more beautiful than the one which he had just described; he complains that he cannot find words to communicate the pleasing impressions which he himself received. Entirely unacquainted with botanical science, even though he had obtained, by the aid of some Arabian and Jewish physicians, a slight superficial knowledge of the vegetation in Spain, the simple love of Nature enables the discoverer to comprehend every individual object which was previously unknown to him. He distinguishes in Cuba seven or eight different species of palm trees, which were more beautiful than the date trees, "variedades de palmas superiores a las nuestras en su belleza y altura;" he informs his talented friend, Anghiera, that he has seen firs and palm trees "palmeta" and "pineta" grouped together and wonderfully mixed in the same plain; he examines the vegetation with such attention that he was the first to remark that in Cibao there were pine trees upon the mountains, which did not bear fir-apples as their fruit but berries, like the olives of "Axarafa" of

Seville. Columbus has also, as I have above remarked (84), separated the genus Podocarpus from the order of the Abietineæ.

"The charm of this new country," says the discoverer, "exceeds that of the 'Campâna de Cordoba.' All the trees shine with evergreen foliage and are always covered with fruit. Upon the earth the shrubs are high and blooming: the breezes are warm as in April at Castilia: the nightingale sings more sweetly than we can describe. In the night, other and smaller birds sing even more sweetly, and I hear too grasshoppers and frogs. Once I came into a deep and inclosed bay, and saw what no eyes have seen before; high mountains from which lovely streams were flowing down (lindas aguas); the mountains were covered with pines and other trees manifold in their forms and covered with splendid blossoms. Steering up the stream which opened into the bay, I was astonished at the cool shade, the crystal water and the number of the singing birds. It seemed to me that I could never leave this place, as if a thousand tongues would be insufficient for the description, and as if it required the hand of a magician to write it down "para hacer relacion a los Reyes de las cosas que vian no bastaran mil lenguas a referillo, ni la mano para lo escribir, que le parecia questaba encantado (85)."

We learn here from the journal of quite an uneducated sailor, what power the beauty of Nature, in various and particular forms, can exercise over the imagination of a susceptible mind. His feelings ennoble his words, for the prose of the Admiral, especially when in his 67th year he is describing the fourth voyage of his noble

undertaking on the coast of Veragua [86], if not more eloquent, is at any rate more exciting than the allegorical and fantastical poem of Boccacio and the two Arcadias of Sannazaro and Sidney, than Garcilasso's "Salicio y Nemoroso," or the "Diana" of George of Montemayor. The elegiac pastoral element of the Italian and Spanish literature lasted too long. It requires the lively pictures in which Cervantes has represented the Adventures of the Knight of La Mancha, to eclipse the "Galatea" of the same author. Although beauty in the language and tenderness of feeling in the works of the above named great poets, very much heighten the beauty of the pastoral romance, it still preserves its cold and wearying nature, like the allegorical and artificial poems of the middle ages. Character and genius in the observer, alone lead to accuracy in the representation of Nature. In the finest descriptive stanzas [87] of "Jerusalem Freed," I have fancied that I can recognize the impressions of the picturesque scenery in the poet's neighbourhood and recollections of the living landscape of Sorrent.

That particular truth in the description of Nature which originates from personal examination, is seen in the greatest richness in the grand national poem of the Portuguese literature. Like the fragrance of an Indian flower, it pervades the entire poem, of which the scene is in a tropical climate, in the rocky grotto at Macao and in the Moluccas. I am not inclined to confirm the bold sentence of Frederick Schlegel, according to whose opinion the Lusiades of Camoens "far surpass in colour and richness of fancy the poems of Ariosto" [88]. But as an observer of Nature, I must add that in the descriptive

parts of the Lusiades, the genius of the poet, the ornaments of the language, and the sweet sounds of melancholy never interfere with the accuracy of the description of physical phenomena; but as is always the case when art springs from a clear source, they rather heighten the lively impression of the greatness and truth of these pictures. The continual relations of the air and sea, of the various forms of the clouds, their meteorological processes, and the different conditions of the surface of the ocean, are described in an inimitable way by Camoens. He represents to us at one time the surface curled by the gentle breeze, as the short waves glitter and shine in the play of the reflected rays; at another as Coelho's and Paul de Gama's vessels are struggling against the deeply excited elements in the midst of a fearful tempest (89). Camoens is in the peculiar sense of the word, a great painter of sea pictures. As a soldier, he had fought at the foot of Mount Atlas in the regions of Morocco, on the shores of the Red Sea, and Persian Gulf; he had twice sailed round the Cape of Good Hope; and possessed with a deep sense of the beauties of nature, he had for sixteen years carefully observed all the phenomena of the ocean on the coasts of India and China. He describes the electrical fire of St. Elms (the Castor and Pollux of the ancient Grecian sailors) "the living light (90) which is sacred to sea-faring men;" he describes the threatening danger of the water-spout in its gradual formation, "how the vapour composed of fine mist, twists itself in a circle, and letting down a thin tube draws up the water as if it thirsted; how, when the dark cloud has satiated itself, it draws away the lower part of the funnel, and restores to

the tide as fresh water, that which the roaring water-spout had taken from it before" ([91]). "The learned writers," says the poet, (and he says it almost to the shame of the present day), "may endeavour to explain the hidden wonders of the world, since under the directions of genius and science alone, they so willingly set down as false, that which we hear out of the mouths of sailors, whose only guide is experience."

The descriptive power of this spirited poet does not only dwell upon single phenomena, but he treats of matters involving a wide and comprehensive view. The third canto describes in few lines, the form of Europe ([92]), from the coldest northern extremity "down to the kingdom of Lusitania, and to the straits where Hercules performed his last work." He especially alludes to the customs and the degree of civilization in the manners of different races which inhabit this quarter of the globe. From the Prussians, Muscovites, and the nations "que o Rheno frio lava," he hastens to the splendid plains of Hellas, "que creastes os peitos eloquentes, e os juizos de alta phantasia." In the tenth canto, he takes a still wider view. Tethys leads Gama to the top of a high mountain, in order to reveal to him the secrets of the earth's construction, "machina do mundo," and the course of the planets, according to Ptolemean astronomy ([93]). It is a vision after the manner of Dante, and as the earth forms the centre of the universe, a complete acquaintance with all the countries which had at that time been investigated, together with their productions, is included in a description of the earth ([94]). It is here not sufficient for him to represent Europe alone, as he did before in the third

canto, but all parts of the earth must be examined, even "the land of the Holy Cross" (the Brazils), and the coasts discovered by Magellan, ("by the deed, but not by the fidelity of a son of Lusitania,") are here mentioned.

When I particularly praised Camoens as a painter of sea pictures, it was with a view of pointing out, that life upon land has been represented by him in less lively colours. Already has Sismondi remarked with justice, that the entire poem contains no trace of any ideas about the vegetation of the tropics, and the characteristic forms of the trees. Only spices and the useful articles of commerce have been alluded to. The episode of the Magic Isle (95), gives us a most pleasing picture of a landscape; but the flowery covering of the earth is formed as an "Ilha de Venus" should be, of myrtles, citron trees, fragrant lemons and pomegranates," all of which are peculiar to the climate of the south of Europe.

In the writings of the greatest sailor of that time, Christopher Columbus, we find more expression of delight in the view of the wooded coasts, and more attention to the forms of the vegetable world; but Columbus is writing a journal of his voyage, whilst the object of the epic poems of Camoens, is to celebrate the great deeds of the Portuguese. To borrow the names of plants from the natives and to interweave them with the description of a landscape, in the foreground of which the actors in the scene are moving, cannot but be distasteful to a poet, accustomed to harmonious sounds.

The equally romantic account of a Spanish warrior, who served under the great emperor in Peru and Chili, and, in tha distant region celebrated in songs the deeds

of arms, in which he took a most distinguished part, has been frequently compared with the dignified style in the poetry of Camoens. In the entire poem of the Araucana of Don Alonso de Ercilla, personal acquaintance with the country, the sight of volcanos covered with eternal snow, glowing valleys in the woods, and the arms of the sea extending far into the country, have given rise to nothing which can be called representation. The excessive praise which Cervantes, on the occasion of the highly satirical examination of Don Quixote's books, lavishes upon Ercilla, is chiefly elicited by the warmth of the rivalry between the Spanish and Italian poets. We might almost say that it has misguided the opinion of Voltaire and several more recent critics. The Araucana is, however, a work which is pervaded by a noble national feeling; the pictures of the manners of a wild race of people, subdued in a contest for the freedom of their country, are full of life; but the style of Ercilla is heavy, too full of proper names, without any trace of poetic spirit ([96]).

This spirit is found in many verses of the "Romancero Caballeresco" ([97]); in the religious melancholy of "Fray Luis de Leon," for instance, in his "Happy Night," where he sings of the eternal lights, ("resplandóres eternales") of the starry sky ([98]), and in the great imaginative works of Calderon. "As the comedy of the Spaniards has been worked up to a high state of perfection," says the deepest investigator of old dramatic literature, my noble friend Ludwig Tieck, "we often find in Calderon and his cotemporaries, in romances and metrical odes, and ballads, beautiful delineations of the sea and mountains, gardens and wooded valleys; but almost always with

allegorical significations, and covered over with an artificial gloss, which does not allow us so much to feel the free air of nature, the reality of the mountains, or the shades of the valleys, as to perceive that a spirited and variegated description of these objects is given in harmonious and lively verses. In the play "Life is a Dream" (la Vida es sueño), Calderon makes Prince Sigismund complain of his unlucky imprisonment, as a striking contrast with the freedom of all organized beings. He paints the habits of the birds, "which move in rapid flight through the air," the fishes which, when but just spawned and scarcely separate from their native mud, seek the wide sea, whose endless space does not appear to satisfy them in their sprightly movements. Even the rivulet running forwards in its narrow and flowery path, has a free course upon the soil. "And I," says Sigismund full of despair, "who have more life, must with my freer spirit submit to less freedom." In a similar way, but frequently disfigured by antitheses, witty similes, and artificial pictures of the school of Gongora, Don Ferdinando in the "Noble Prince," addresses himself to the King of Fez (99). I allude especially to these individual instances, because they show, how, in dramatic writings which particularly exhibit the occurrences, emotions and characters of mankind, descriptions are only views of the spirit and disposition of the actor. Shakspeare who in the press of his occupations, scarcely found time or opportunity to devote himself earnestly to a delineation of Nature, paints, by means of events, magnificent and spirited pictures of the landscape and natural scenery, so that we can believe we see them before us,

and appear to live amongst them. Thus in "Midsummer's Night Dream," we live in the wood; we see the last scene of the "Merchant of Venice," by moonlight, in a warm summer night, without there being any special description of either. The description of the cliff at Dover in "King Lear," is a genuine picture of the scene where Edgar simulating madness, leads his blind father Gloster, along the plain, as if they were mounting the cliff. The account of the view from the summit, looking down into the depth beneath, causes almost a sensation of giddiness" ([100]).

As the real and lively feelings, and the noble simplicity of Shakspeare's language, give such life to his representations, and to the particular expressions of his fancy, so in the elevated poetry of Milton's "Paradise Lost," as the peculiarity of the composition requires, the description of scenery is rather magnificent than natural. The entire richness of his fancy and language is expended in the description of the blooming garden of Paradise; but here as in Thomson's lovely and instructive poem on the "Seasons," the picture of vegetation could only be represented in a general and indefinite sketch. According to the expressed opinion of one deeply acquainted with Indian poetry, Kalidasa's poem upon the same subject, "Ritusanhara," which is considerably more than one thousand five hundred years old, describes the luxuriant tropical vegetation with more life; but it wants the grace, which in Thomson originates from the more decided distinction between the seasons, peculiar to the northern latitudes; from the gradual change from the fruitful autumn to winter, and from winter to the renewal of

spring, and from the account of the laborious or cheerful life of the inhabitants at each time of the year.

If we pass to times nearer to us, we shall remark that since the second half of the eighteenth century, descriptive prose has attained peculiar force. Although, from a widely extended study of Nature, the amount of knowledge is immeasurably increased, yet among the few who are capable of a higher degree of inspiration, an intellectual view of the subject is not oppressed by the actual weight of information. This view (the spontaneous production of poetical genius) has rather increased in extent and sublimity, since our insight has penetrated further into the structure of mountains (the regularly arranged burying-places of departed organic beings), into the geographical distribution of animals and plants, and into the relation and differences in the various races of mankind. In this way, by excitement of the imaginative faculties, very great influence in the creation of a taste for Nature, and intercourse with her beauties, and the desire for travelling, inseparably united with these feelings, was at first exerted by the following writers:—In France, by Jean Jacques Rousseau, Buffon, Bernardin de St. Pierre, and (to name here, by way of example, an author who is still living) my old friend August von Chateaubriand; in the British Isles, the talented Playfair; in Germany, Cook's companion in his second voyage round the world, the eloquent George Forster, so happily connected with the subject of the generalization of natural laws.

It must be altogether left out from these pages, to inquire as to what characterized each of these authors, what gave to the delineations of landscapes, in their very

extensive works, their peculiar charm and attraction, or what disturbs the impressions which they would call up; but it may be permitted to a traveller, who owes his information chiefly to an immediate and personal examination of the World, to bring forward his own scattered reflections concerning this recent and almost untrodden path of literature. Buffon, noble and earnest, comprehending at the same time the nature of planets, the laws of organization, light and the magnetic forces, was much more deeply acquainted with physical inquiries than his cotemporaries imagined him to be: when he passes from the habits of animals to the descriptions of scenery, he is rather pompously oratorical in his artificially formed sentences, than true in particulars, and aims more at a susceptibility for what is sublime, than to convince the mind by delineation of real natural life. We feel, even in his admirable attempts of this kind, that he never could have left the middle of Europe, and that a personal inspection of the tropical world, which he fancies he is describing, was altogether wanting. But what we especially miss in the works of this great author, is the harmonious combination between the representations of Nature and the expressions of his excited fancy; in fact, almost everything, which springs from the mysterious analogy between the mental emotions and the phenomena of the world of sense, is absent in his writings.

Great depth of feeling and a lively spirit breathe in the works of Jean Jacques Rousseau, in Bernardin de St. Pierre, and in Chateaubriand. If I here mention the charming eloquence of the first of these authors, and the

picturesque scenes of "Clarens and Meillerie" on the Lake of Geneva, it is because of the animation, especially manifest in the peculiar language of this unlearned, but zealous collector of plants, whose works are twenty years older than Buffon's imaginative "Ages of Nature" (101), and whose eloquent diction bursts forth and flows as freely, as in the works of fiction of Klopstock, Schiller, Goethe and Byron. When nothing is aimed at which is immediately connected with the study of Nature, yet then even our love for it, may be elevated by the magic of a poetical description and life, though within the compass of a narrow and familiar region.

As we have here returned to the prose writers, we willingly tarry awhile, to consider that little production to which Bernardin de St. Pierre owes the greater part of his literary fame. "Paul and Virginia," (and literature possesses none such work besides) is the simple natural picture of an island in the middle of a tropical sea, where at one time protected by the mildness of the climate, at another threatened by the mighty strife of the elements, two attractive forms wander, on the blossoming carpet in the wild luxuriance of the wood. In this and in the "Chaumière Indienne," and even in "les Etudes de la Nature," which are disfigured by adventurous theories, and physical errors, the view of the sea, the gathering of the clouds, the noise of the breezes in the bamboo bushes, the waving of the branches of the lofty palm, are represented with inimitable truth.

Bernardin de St. Pierre's master-work, "Paul and Virginia" has accompanied me to the regions in which the scene is laid. It was for many years read by me, and

my dear companion and friend Bonpland; there (I may be pardoned for bringing forward my own feelings) in the glowing stillness of a southern sky, or when in the rainy season, on the banks of the Orinoco, the lightning flashed, and illuminated the wood, we were both struck by the wonderful truth, with which the rich and peculiar scenery of the tropics was painted in that little book. Such a close attention to particulars without injuring the general impression, and without depriving the subject matter of the free and lively imagination of the poet, characterizes in a still higher degree, the spirited and sensitive author of "Attila," "Réné," "The Martyrs," and the "Journey to Greece and Palestine." In his works all the contrasts of the landscape in the most different regions of the earth, are collected together with wonderful accuracy. Earnestness and vivacity of historical recollections, can alone give depth and repose to the impressions of a rapid journey.

In our German native country, and also in Italian and Spanish literature, the expression of a taste for scenery has too long been confined to the artificial form of pastoral or shepherd's songs, and of didactic poetry. The Persian traveller, Paul Flemming, Brockes, the sensitive Ewald von Kleist, Hagedorn, Solomon Gessner, and one of the greatest natural inquirers of all ages (Haller, whose local delineations, at any rate exhibited more certain sketches, and more objective truth in their colouring), have all of them followed in this path. The elegiac and pastoral element was predominant in the melancholy poems of the country, and the poverty of their contents could not be concealed even in "Voss," (so distinguished and well acquainted

with classical antiquity), by a higher and happier choice of language. When first the study of the earth's surface became deeper and more varied, and when the natural sciences no longer limited themselves to the tabular arrangements of rare productions, but were raised to the extended view and the comparison of different countries, that style of composition could no longer be used in the lively delineation of distant lands.

The older travellers of the middle Ages, as John Mandeville (1353), Hans Schiltberger (1425), and Bernhard von Breytenbach (1486), delight us even to the present day, by their living simplicity, the freedom of their speech, and the security with which they come before the public, who are altogether unprepared, and attend with so much the more curiosity and credulity, because they have not yet learnt to blush at appearing delighted or even astonished. The interest of travels was then almost dramatic, and indeed the necessary, and at that time, the so easy introduction of what was wonderful, gave them almost an epic colouring. The manners of the people were only described, as far as they were seen in the intercourse between the traveller and the natives. Vegetation remained unnamed, and unobserved, except that here and there, a very delightful or wonderfully formed fruit, or a stem of a tree of remarkable dimensions, or with extraordinary leaves, attracted their attention. Among animals, those that were like men, or wild and dangerous, were described with great zest. The cotemporaries of the travellers believed in all the dangers, of which in such climates, few among them had participated. The tediousness of the voyage, and the want of methods of

communication made the Indian countries (for so they termed the whole of the space between the tropics) appear as at an immeasurable distance. Columbus (102) had as yet no right to say to Queen Isabella, "the earth is not large, it is much smaller than people consider it to be."

However, in respect of composition, these by-gone travellers of the middle ages, to whom I am now alluding, with all their deficiency of matter, had numerous advantages over the majority of recent travellers; they had the unity which every work of art requires, all was directed to one subject, every thing was subordinate to the occurrences of the voyage itself. The interest chiefly consisted in the simple and lively narration of difficulties, which they had overcome, and which were generally considered to be worthy of credit. Christian travellers unacquainted with what the Arabians, Spanish Jews, and Buddhist missionaries had done before them, gave themselves the credit of having first seen and described these wonders. In the darkness in which the east and the inland parts of Asia seemed to be enveloped, the distance magnified the particular objects. This kind of unity is wanting in the compositions of most modern travellers, especially of those who had some scientific object in view. The treatment of the subject with them was secondary to their observations, and was lost in the fulness of their descriptions. Only the laborious, and at the same time but little instructive, ascent of mountains, or a bold voyage, or certain particular voyages of discovery, in the almost unknown seas, or a sojourn in the horrid desert of the icy polar zone, impart a dramatic interest to the subject, whenever it became possible to describe particular

scenes. The loveliness of the neighbourhood, and the helpless seclusion of the sailors, isolate the picture, and thus excite the powers of the imagination, to a much greater degree.

Now after the foregoing considerations it cannot be denied, that in the more recent descriptions of travels, the element of action is left in the back ground, and that the greater number, have only become a means of connecting together, in regular succession, the observations of Nature, and the customs of various nations; but this partial view of the subject is amply compensated for, by the richness of the facts collected, by our more extended knowledge of the world, and by the laudable endeavour of each writer to make use of the peculiarities of his own language, in his particular representation. That which more modern cultivation has brought to us is the continued progress and expansion of our views, a growing fulness of our ideas and feelings and their strong and mutual reaction. Without leaving our native soil, we can not only learn how the crust of the earth is composed in the most distant regions, and what species of plants of animals live there; but we are also provided with a picture which gives in a lively way, at least a part of the impressions, which man, in that region of the world experiences. Modern travellers labour to satisfy this demand for a kind of a spirited joy which was unknown to antiquity: the work succeeds because it is a general object of all civilized nations, and because the perfection of the means of locomotion upon land and sea make all the world accessible, and all its separate parts at the greatest distances can thus be easily compared together.

I have here endeavoured to show the direction towards which the representative power of the observer, the degree of animation and the multiplicity of our views in this vast theatre of creating and disturbing forces can tend, in order to stimulate and expand our scientific study of Nature. The writer who in the literature of our native land, according to my ideas, has commenced the journey along this path, most powerfully and most successfully, is my distinguished teacher and friend, George Forster. Through his means a new era of scientific travels began, the object of which is the comparative examination and various countries and nations. He is endowed with a fine moral feeling, and preserves in his mind, as did also Charles Darwin ([103]), the lively pictures of Taheiti and the South Sea Islands (so happy a country at that time). He first described with life and accuracy the changes in the vegetation, the relations of the climate, the kind of food in reference to the habits of the people, the difference of their dwelling places, and their original descent. Everything which can impart truth and a special and intelligible view are given in his work. Not only in his splendid description of the Second Voyage of Captain Cook, but more decidedly in his smaller writings do we detect the fine germ of much that is great and which later times have matured([104]); but even so noble, sensitive, and sanguine a life was not allowed to be a happy one!

The delineations of Nature of modern times in which the literature of Germany, France, England and North America, especially abound, have been highly censured, and named "Descriptive Poetry of the Landscape;" but these terms only indicate the abuse which may be laid to

the charge of supposed extension in the limits of any art. Poetical descriptions of natural productions, as Delille has given them, at the end of his long and distinguished career, with all their expenditure of fine language, and the aid of metre, can in no way be looked upon as poetry of Nature, in the higher sense of the term. They are without an animated and a truly poetical basis, and are dull and cold, like everything which glitters from external ornaments alone. If therefore the so-called "Descriptive Poetry," as a separate and distinct kind of work is rightly censured, yet this disapprobation, certainly does not apply to earnest endeavours to make the result of more recent and complete examination, intelligible by means of language. Has any mode remained unapplied, which can give us a lively picture of distant countries visited by others, or which can supply a part of the pleasure which the immediate contemplation of Nature affords? The Arabians say figuratively and sensibly "that the best description is that which turns an ear into an eye(105)." It is one of the misfortunes of the present day, that a faulty propensity to vapid poetical prose, and to the emptiness of so-called spirited effusions, has affected the most meritorious travellers and writers upon Natural History in many countries, at the same time. Errors of this kind are more distasteful if for want of a literary education, or especially from the absence of elevation in the feelings, the style degenerates into rhetorical bombast and obscure sentiment.

The descriptions of Nature, I here repeat, may be sharply defined and accurate in a scientific point of view, without being deprived of the lively aspirations of the

imagination. Poetry must arise from the resemblance and connection between what is within the cognizance of the senses, and that which is intellectual; and from the feeling of vastness on the one hand, and of the limitation and the unity of Nature on the other. The more elevated the subject is, so much the more carefully, must the outward ornaments of language be avoided. The peculiar effect of a picture of scenery depends upon its composition; every intentional change on the part of the painter only disturbs its harmony. He who is acquainted with the great works of antiquity and is complete master of his own language, will know how to communicate in a simple and particular way, that which he has obtained by personal observation, and will not fail to convey a true impression; and this will be so much the more certain, the less he expresses his own sentiments, instead of the voice of external Nature around him, leaving the freedom of thought in others altogether unfettered.

But it is not only the lively account of that richly adorned land of the equinoctial zones, in which intensity of light, moisture and warmth, heighten and accelerate the development of organic germs, that has in our time given the powerful inducement to the extended study of Nature. The secret charm which acts by exciting a deep view into the processes of organized life, is not limited to the tropical world alone. Every latitude shows the wonders of creation, continually progressing or recurring in slightly different forms. The wonderful empire of Nature's powers is extended everywhere; she guides the contending elements in the overcast sky, and superintends the deposition of the delicate materials in

the living tissues. Therefore, all parts of the wide circle of Creation, from the equator to the frigid zone, wherever Spring unfolds a single bud, may rejoice in the enlivening feeling of her presence. My native country Germany, justifies this belief more than any other. Which of the southern nations does not envy us our great master-poet, whose works are pervaded with so deep a feeling of nature, in the "Sorrows of the Younger Werther," the "Recollections of Italy," in the "Metamorphosis of Plants," and in his "Miscellaneous Poems?" Who has with more eloquence stimulated his cotemporaries to solve "the holy riddle of the universe;" to renew the bond which in the days of man's youth, surrounded Philosophy, Physic and Poetry with one single band? Who has more strongly attracted us to the land so peculiarly his own, where

> "The fragrant myrtle and the verdant bay
> Scarce feel the breezes of the sultry day."

II.—LANDSCAPE PAINTING CONSIDERED IN ITS INFLUENCE UPON THE STUDY OF NATURE.—GEOGRAPHICAL REPRESENTATIONS OF THE CHARACTERISTICS OF PLANTS.—PECULIARITIES OF THEIR FORMS IN DIFFERENT ZONES.

LANDSCAPE Painting, as well as a lively verbal description, is adapted to elevate our love for the study of Nature. Both show us the external world in all its rich multiplicity of forms; both are able, according to the greater or less degree of success in their expression, to connect that which is apparent to our senses, with that which is immaterial. The endeavour to arrive at such a connection, indicates the last and most elevated goal of the pictorial art. These pages, from the scientific object to which they are devoted, are limited to another purpose; we can only consider the art of Landscape Painting, as far as it represents to us the characteristics and the physiognomy of different regions of the earth, as it increases our desire for travelling into distant lands, and in an instructive and spirited way, stimulates us to a freer intercourse with Nature.

In Grecian and Roman antiquity which we call classical, from the peculiar direction in the minds of the

people, Landscape Painting was as little an independent object of art, as was the poetical representation of the country. Both were merely treated as something secondary. Subordinate to other objects, Landscape Painting served only, for a long time, as the back-ground of historical compositions, or an accidental ornament of pictures on the walls. In a similar way, the epic poet, by an artistic description of the landscape—I might almost repeat, of the back-ground, before which the actors in the scene are moving—represents the locality of some pictorial event. The history of the art teaches us, how, from being a secondary, it became a chief object in the representation; how it was separated from historical painting and became an independent branch of art; how the human form soon served only to set off a mountain or a wood-scene, or the picture of a sea-shore or garden. The separation of these two species, the drawing of figures and landscapes, gradually increased, thus favouring the general progress of the art in these two directions. It has been correctly remarked, that if the art of painting, in general, was subordinate to sculpture among the ancients, the feeling for the beauties of the landscape, which are communicated by means of the pencil, is not ancient but modern.

Graphical representations of the peculiarities of a region must, indeed, have been found in the oldest pictures of the Greeks, if, to bring forward some individual examples, according to Herodotus' (106) account, Mandrocles of Samos caused the passage of the army over the Bosphorus to be represented for the great Persian King, or if Polygnot (107) painted the destruction of Troy on the walls of the

temple at Delphi. Among the pictures which the elder Philostratus described, a landscape is mentioned, in which the smoke was seen rising from the summit of a volcano, and streams of lava pouring into the nearest sea. In this elaborate composition of a view of Seven Islands, the newest (108) commentators believe, that they recognize the representation of an actual region, the little Æolian or Liprarian group of volcanic islands to the north of Sicily. The perspective theatrical paintings, by which the master-pieces of Æschylus and Sophocles were illustrated, gradually extended this branch of the art (109), since it increased the demand for a deceptive imagination of inanimate objects, such as buildings, woods and rocks.

When the painting of scenes had become perfect, the drawing of landscapes among the Greeks and Romans who imitated them, was transferred from the theatre to their halls adorned with pillars, where the long surfaces of the wall were at first covered with pictures of limited scenes (110), and afterwards with the wide prospects of towns, shores of the sea, and extensive pastures, upon which the cattle are feeding (111). The Roman painter, Ludius, did not discover these spirited decorations of the walls in the age of Augustus; but they had become generally approved (112), and were rendered more cheerful by the introduction of little figures (113). About the same time, and even a half a century earlier, we find among the Indians, in the renowned age of Vikramaditya, that Landscape Painting was mentioned as a much practised art. In the exciting drama of Sakuntala, the picture of his beloved is shown to the King Duschmanta. He is not content with it, for he wishes "that the female painter

should represent the places which were especially dear to her friend. The river Malini, with a sand-bank, upon which the red flamingos stand, a chain of hills which extend to the Himalaya Mountains, with gazelles reposing there." These are requisitions of no slight nature; they show, at least, a belief in the possibility of representing an elaborate composition.

Since the time of the Cæsars, Landscape Painting at Rome became a distinct branch; but, according to the many specimens which have been discovered in Herculaneum, Pompeii and Stabiæ, these pictures of Nature were often only map-like views of the country, more allied to the paintings of harbours, villas and artificial gardens, than of the open country. The Greeks and Romans appeared rather to look for a region which was convenient and habitable, than for what we call wild and romantic. The imitation might be close, as far as an extreme carelessness in the perspective, and a desire for fashionable arrangement permitted it; and the arabesque compositions, to which the precise Vitruvius objected, united in their regular recurrence and ingenious treatment, the forms of animals and plants; but to avail myself of an expression of Otfried Müller (114), "The threatening darkness of the spirit, with which a landscape addresses us, appeared to the ancients, according to their notions, incapable of any artificial improvement; their landscapes were rather designed in sport, than with earnestness and feeling."

We have here shown the analogy of the mode of development, in which two means of representing Nature in classic antiquity, by language (spirited expressions) and by

graphical delineations, gradually became independent. That which the latest and most skilfully managed excavations in Pompeii have shown to us of the ancient Landscape Painting, after the manner of Ludius, belongs probably to an isolated and short epoch ([115]), from Nero to Titus; for the town had been totally destroyed by an earthquake sixteen years before the memorable eruption of Vesuvius.

The later Christian painting, with its artificial character, remained, from the time of Constantine the Great to the beginning of the middle ages, very nearly allied to the genuine Grecian and Roman art. It lays before us a treasure of old recollections, as well in the miniatures ([116]) which adorn their splendid and well-preserved manuscripts, as in the rarer Mosaics of that age. Rumohr mentions a manuscript of the Psalms, in the Barberini, at Rome, where, in a miniature, "David strikes his harp, surrounded by a charming grove, from among the trees of which nymphs emerge. This personification points at the ancient source of all these pictures." Since the middle of the sixth century, when Italy became poor and was politically weak, Byzantium in the East preserved, until a happier time, the remains of this slowly expiring branch of art. These specimens form the transition to the productions of the latter part of the middle ages, after the love for the embellishment of manuscripts had spread from the east of Greece, to the west and north to the French monarchy, under the Anglo-Saxons, and to the Netherlands. It is, therefore, a matter of no small importance in the history of this more recent branch of art, "that the renowned brothers, Hubert and John Van

Eyck, have originated from a school of miniature painters, which, since the second half of the fourteenth century, has attained such perfection in Flanders (117)."

Careful delineations of landscapes are first found in the historical pictures of these brothers, Van Eyck. Neither of them had visited Italy, but the younger brother, John, had enjoyed the view of southern European vegetation, when in the year 1428 he accompanied the embassy which the Duke of Burgundy, Philip the Good, sent to Lisbon, to woo the daughter of King John I. of Portugal. We possess here, in the museums of Berlin, the wings of a noble picture, which this painter, the real founder of the great school of the Netherlands, had prepared for the Cathedral Church at Ghent. In these, which represent the holy hermits and pilgrims, John Van Eyck has adorned the landscape with orange trees, date, palms and cypress trees which spread a very characteristic and natural shade over other and darker masses. We feel, upon inspecting this picture, that the painter himself had seen the trees, which are fanned by the warm air of the south.

Whilst considering the master-pieces of the Brothers Van Eyck, we are still in the first half of the fifteenth century, when the art of painting in oils began to displace the former method of distemper painting, and soon obtained a high artificial perfection. The attempt at a lively representation of the forms of Nature was excited; and if we would follow the gradual spread of an elevated feeling for Nature's beauties, we must remember how Antonello di Messina, a pupil of the Brothers Van Eyck, implanted the inclination for Landscape Painting at

Venice, and how the pictures of the school of Van Eyck have, in like manner, reached Florence, by the means of Domenico Ghirlandajo and other masters (118). The endeavours of that time were directed towards a careful but scrupulously exact imitation of Nature. This appears, for the first time, free and grand in the master-pieces of Titian, to whom Giorgione served as a model. I was fortunate enough for many years to have had an opportunity of admiring the picture of Titian in the Museum at Paris, which represents the death of Peter the Martyr(119) surprized in a wood by one of the Albigenses, in the presence of another Dominican monk. The form of the trees, their foliage, the blue distance of the hills, the lights and shadows of the whole, give an impression of earnestness and grandeur, and of depth of feeling which this exceedingly simple composition produces. The feeling for Nature's beauties was so lively in Titian, that he gave to the back-ground of his pictures, a character corresponding to the subject, not only in his likenesses of the beautiful women whom he painted, as in the rich picture of the Venus in Dresden, but, also to the representation of more severe subjects, for example in that of the poet Pietro Aretino, both in the landscape itself and the sky. Such a character of sublimity remains in the Bolognese school, in the works of Annibal Carracci and Domenichino.

But if the grand age of historical painting was the fifteenth century, that of the greatest landscape painters was the seventeenth. By the increasing acquaintance with Nature and the number of careful observations, a feeling for art was enabled to extend itself over a great many objects, and at the same time, the means for painting were brought to

perfection. The relations to the disposition of the mind became more intimate, and thus the tender and gentle impression of the beauties of Nature, increased together with a belief in the power of the external world to excite us. If this excitement, in conformity with the elevated object of all art, changed real objects into subjects for the fancy, and if it induced in us the impression of repose, the pleasure is not without some emotion; it seizes upon the heart whenever we look into the depths of Nature or of mankind ([120]). In one century, we find collected together Claude Lorraine, the pastoral artist of light and the misty distance, Ruysdael with his dark woods and threatening clouds, the noble trees of Gaspard and Nicholas Poussin, and the life-like representations of Everdingen, Hobbema and Cuyp ([121]).

In this happy period of the development of the art, everything which the vegetation of the north of Europe, and the more southern region of Italy and the Spanish peninsula produced, was copied in a spirited manner. The landscapes were adorned with orange and laurel trees, with pines, and date palms. The latter (the only species of this noble genus which, besides the little original European sea-palm, the Chamærops, is known in Europe), was generally represented in a conventional manner, with a scaly stem like a serpent ([122]). This served for a long time for the purpose of representing the whole of the vegetation of the tropics, as the "Pinus Pinea" is very generally considered to characterize exclusively the vegetation of Italy. Views of lofty rocks and mountains were but little studied; even the snow summits which surmount the green meadows of the Alps, were considered at that

time unattainable by natural inquirers and artists. The peculiar characteristics of the cliffs only induced a greater desire to represent them, where the foaming and divided waterfall makes a path for itself on the mountain side. Here too I must notice the many kinds of spirit, which enliven the artist who has deep feeling for Nature's beauties. An historical painter, Rubens himself who in his great hunting pieces, has represented with inimitable liveliness the droves of wild animals, includes at the same time the particular scene in the waste and completely desert and rocky plain of Escorial, with unusual happiness of delineation ([123]).

The views of particular forms in Nature, touching the part of the art, which is the peculiar subject of these pages, could only become more manifold and accurate, when our geographical circle increased, when travelling to distant climates became easy, and a sense for the relative beauties and classification of plants into the groups of natural families, was awakened. The discoveries of Columbus, Vasco de Gama and Alvarez Cabral in Central America, South Asia, and the Brazils, the extension of commerce in spices and drugs, among the Spaniards, Portuguese, Italians and in the Netherlands, the establishment of botanical gardens (although not yet supplied with suitable hot-houses) in Pisa, Padua and Bologna between 1544 and 1568, made the painter at any rate acquainted with those of the tropical world. Particular fruits, blossoms and branches were represented with spirit and with natural truth by John Breughel, whose fame began about the end of the sixteenth century; but there were no landscapes which gave an idea of the peculiar character of

the countries in the torrid zone, drawn upon the spot by the artist himself, before the middle of the seventeenth century. The first merit of such a picture belongs probably, as I have learnt from Waagen, to the painter of the Netherlands, Franz Post of Haarlem, who accompanied the Prince Maurice of Nassau to the Brazils, where the Prince, who took a lively interest in the productions of the tropical world, was the Dutch Minister of State from 1637 to 1644, in the territory taken from the Portuguese. Post for many years made studies from Nature on the Promontory of St. Augustin, in All Saints Bay, and on the shores of the San Francisco, and on the lower part of the course of the Amazon (124). These were partly published by him as pictures, and partly etched with considerable spirit. To this period belong the well-preserved and splendid large oil paintings of the artist Eckhout (in the gallery of the beautiful castle of Fredericksberg), who also visited the Brazilian shores with Prince Maurice in 1641. Palms, melons, bananas and heliconias are drawn in a very characteristic style; even the forms of the natives, the bright coloured birds, and the little quadrupeds.

But few gifted artists followed these examples of the characteristic paintings from Nature, until the second Voyage of Captain Cook round the World. What Hodges did for the Western Islands of the South Sea, and our immortalized countryman Ferdinand Bauer for New Holland and Van Diemen's Land, Maurice Rugendas, the Count Clarac, Ferdinand Bellermann and Edward Hildebrandt have accomplished in more modern times with

much more taste and greater skill, for the tropical regions of America; and Henry of Kittlitz, the companion of the Russian Admiral Lütke in his Voyage round the Earth, for many other parts of the world ([126]).

He who is endowed with a susceptibility for the natural beauties of mountains, streams, and forest scenery; who has wandered through the countries of the torrid zone, and has seen the luxuriant variety of the vegetation, not only upon the cultivated shores, but in the vicinity of the snow-capped Andes, the Himalaya Mountains, and the Neilgherry Hills of Mysore, or in the wide forests of the country between the Oronoco and the Amazon; that man can alone understand what an immeasurable field for Landscape Painting is open between the tropics of both continents, or in the islands of Sumatra, Borneo and the Philippines, and how the most splendid and spirited works which Man's genius has hitherto accomplished, cannot be compared with the vastness of the treasures of Nature, of which Art may, at a future time, avail itself. Why should there not be a good foundation for the hope, that Landscape Painting will flourish with a new and hitherto unknown vigour, if talented artists can more frequently wander over the confined borders of the Mediterranean Sea, and if they are also permitted, at a distance from the coast, and possessed of the original freshness of their youthful spirit, to embrace the manifold varieties in Nature's forms in the humid valleys of the mountainous regions of the tropics?

These grand regions have hitherto been only visited

by travellers, whose want of early education in the art, and the direction of the mind to other scientific pursuits, have given them but little opportunity of perfecting themselves in Landscape Painting. A very few of them were able to convey any expression of tropical scenery, in connection with the botanical interest excited by particular forms in the flowers and leaves. The scientific men who accompany the great expeditions which are equipped at the expense of the nation, are often chosen, as it were by chance, and are generally much more poorly provided than such a purpose requires. By the time the more talented of them, from their continued view of grand scenes and frequent attempts to copy them, have attained a certain degree of artificial skill, the journey is already drawing to a close. Moreover, the so-called Voyages round the World are but little calculated to bring the artist into any very characteristic woodland country, or to the upper part of the course of great rivers, or upon the summits of inland hills.

Sketches drawn from Nature, can alone, after the return from the voyage, enable us to represent in more elaborate landscapes the peculiarities of distant regions; they will be all the more perfect if the artist has, at the same time, drawn or painted from Nature in the open air a great number of separate studies of the tops of trees, leafy branches well covered with blossoms or fruit, fallen trunks of trees, with orchideous plants upon them, rocks, banks of the rivers, and small portions of the country. The possession of these studies from Nature, accurately designed and sketched, can alone prevent the artist, upon

his return, from being misled by the assistance which he obtains from hot-house plants and the so-called botanical pictures.

An important historical event, the separation of Spanish and Portuguese America from the empire of European powers, the increase of cultivation in the Indies, New Holland, the Sandwich Islands and the southern colonies of Africa, will infallibly give a new character and a great impulse, not only to meteorology and the mere description of Nature, but also to the art of painting landscapes, which, without these relations between the countries, it would never obtain. In South America there are populous cities nearly thirteen thousand feet above the level of the sea. From thence downwards, all the various climatic gradations in the forms of plants meet the eye. How much may we not expect from the picturesque study of Nature, if, after the termination of civil strife and the restoration of freedom in their constitution, a taste for Arts and Science is at last awakened in those high lands!

Every thing which refers to the expression of the emotions, or to the beauty of the human form, has been able to attain its highest perfection in the temperate northern zone, under a Grecian or western sky: the historical painter can call up from the depth of his feeling, or from an actual inspection of mankind, copies for the exercise of his skill: he may use the powers of his fancy or of imitation. The art of Landscape Painting, which is more than mere copying, has a more material subject, and is very closely connected with the Earth; it requires a great number and variety

of actual and sensible observations, which the mind must embrace and fertilize by its own power, and then restore to the senses, as a new work of Art. The grand style in landscapes is the product of a deep comprehension of Nature and this internal mental process.

Nature in every corner of the world is a mere reflection of the whole. The forms of organization are reflected in different combinations. Even the icy north enjoys for many months in the year the verdure of its soil, the Alpine flowers with their large blossoms and the blue sky. The art of Landscape Painting has hitherto perfected its attractive work amongst us, being only acquainted with our more simple flora, but not therefore being destitute of depth and fulness of creative fancy; it has dwelt upon the plants of our native land, and passed through their narrow circle; but even in this, the highly gifted artists, the Carracci, Gaspard Poussin, Claude Lorrain and Ruysdael, have found sufficient space in the change of the forms of the trees and by the management of the light, to call up as it were by magic, the happiest and most varied fancies. That which art has still to expect, and to which I must draw attention, in order to keep in sight the union of natural science with poetry and a taste for painting, will not diminish the fame of those master-pieces; for as we have already remarked, in Landscape Painting and in every other branch, we have to distinguish between the productions of limited skill with actual and immediate observation, and that which arises freely from the depth of the feelings and the vigour of poetical genius. The grandeur which Landscape Painting, as an animated poem, owes

to this creative power in the mind, like a man endowed with imagination, is not bound down to the earth; (I here remember the regular succession in the forms of the trees from Ruysdael and Everdingen, by Claude Lorrain up to Poussin and Annibal Carracci). In the great masters we can trace no sign of any local limitation; but extension of the visible horizon and acquaintance with what is grand and noble in Nature, and with the luxuriance of life in the tropical world, give to less gifted artists the advantage, that they not only are able to increase the subjects for Landscape Painting, but also to excite a more lively feeling, and thus to elevate their art.

I may be here allowed to bring forward the considerations which I published nearly half a century ago, in a treatise, which was but little read, entitled, "Ideas upon the Physiognomy of plants" ([126]); considerations which have the most close connection with the subjects of our present remarks. He who knows how to include in a single view, the whole of Nature, and abstract himself from local phenomena, recognizes, how with the increase of warmth from the Pole to the Equator, the power and richness of organic life also gradually increase. The charms of Nature differ less in passing from the North of Europe to the lovely shores of the Mediterranean, than in passing from the Spanish peninsula, or from the South of Italy and Greece, towards the tropics. The carpet which the blooming Flora spreads out over the bare earth is unequally woven; thicker where the sun rises higher into a sky, deep and clear, or covered with light clouds; thinner towards the misty north, where the returning

frost now kills the sprouting bud, and now cuts off the ripening fruit. If, in the frigid zones, the bark of the trees is covered with decayed spots, or leafy moss; in the regions of the feathery palm-trees, Cymbidium and the aromatic Vanilla enliven the trunks of the Anarcardeæ and the gigantic fig-trees. The fresh green of the Drachontium, and the deeply-cut leaves of the moss, contrast with the many-coloured blossoms of the Orchis; the twining Bauhinia, Passion-flower, and the yellow-blossomed Banisteria, climb far and high into the air, round the stems of the forest-trees; delicate flowers unfold themselves from the roots of the Theobroma as from the thick and rough bark of the Crescentia and the Gustavia. In this multitude of flowers and leaves, in this luxuriant growth and this confusion of climbing plants, it often becomes difficult to the botanist to distinguish to which tree the blossoms and leaves belong; indeed, a single tree, adorned with Paullinias, Bignonias, and Dendrobium, presents a multiplicity of plants, which, if separated one from the other, would cover a considerable space.

But each latitude preserves its peculiar beauties; the tropics have the wonderful variety and elevated forms in vegetation; the north has the corn-fields and the periodical and gradual resuscitation of Nature at the first breath of Spring. As in the Musaceæ, the vessels in the leaves attain their greatest expansion, so in the Casuarineæ they are most contracted. Fir-trees, Thuja, and Cypress-trees are a northern type, which is very rare in the tropical regions. The freshness of their evergreen leaves cheers the desert winter landscape; it proclaims to the inhabitants of these regions, that although snow and ice

cover the earth, the internal life of the plants, like the fire of Prometheus, is never extinguished.

Each latitude has also its peculiar character, and gives rise, to various impressions in us. Who, in recalling the varied scenery of his native land, does not feel himself differently associated with the dark shadows of the beech-trees—with the hills encircled by fir-trees, or with the wide grassy plain, where the wind murmurs in the trembling foliage of the birch-trees. As we recognize a certain physiognomy in single organic beings, and as descriptive botany and zoology are, in a narrower sense of the word, the dissection of plants and animals, so there is also a certain *Physiognomy of Nature,* which belongs exclusively to each latitude. That which the artist means by the expressions, 'Swiss scenery,' and 'Italian sky,' is founded upon some obscure idea of the natural character of the place. The blueness of the sky, the forms of the clouds, the distant mist, the richness of the herbs, the brightness of the foliage and the outlines of the hills, are the elements which determine the general impression of a scene. To comprehend this, and to communicate it visibly to others, is the province of Landscape Painting. It is the duty of the artist to separate these groups, and under his hand (if I may use this figurative expression) the great and charming picture is dissolved, like the written works of man, into a few simple lines.

But even in the present imperfect condition of the pictorical representations of the landscape, which accompany and often disfigure, (in the shape of copper-plates,) the reports of travels, yet have they not a little added to our acquaintance with the characters of distant lands, to

the inclination for travelling into distant lands, and to a more active study of Nature. The perfection of these paintings in vast dimensions, (as decorations, panoramas, dioramas, and neoramas), has, in more modern times, much increased the strength of the general impression. What Vitruvius and the Egyptian, Julius Pollux, delineate as "rustic decorations of the stage," that which in the middle of the sixteenth century, by means of Serlios' contrivances of the scenes, increased the deception, may now, since the master-works of Prevost and Daguerre, in the circular pictures of Parker, almost replace a visit to different climates. The panorama has more effect than the stage scenes, because the spectator, as if enclosed within a magic circle, and removed from all the disturbances of realities, feels himself surrounded with strange scenery. It leaves impressions behind, which, in after years, are wonderfully mixed up in the mind with the scenes in Nature which have been really visited. Hitherto the panoramas, which only are effective if they have a great diameter, have been rather confined to views of towns and inhabited regions, than to the representation of those prospects in which Nature abounds in the wild luxuriance and fulness of life. Characteristic studies, sketched from the abrupt precipices of Himalaya and the Cordilleras, or in the interior of the Indian and South American continents, with their numerous rivers, and represented by transparencies, in which not the foliage but the peculiar form of the gigantic stems, and their mode of branching, are well set forth, would have an almost magical effect.

All these means, an account of which actually belongs

to the work on "Kosmos," are particularly adapted to increase the love for a study of Nature: and the acquaintance and feeling of the elevated greatness of Creation would be much heightened, if in the great towns, besides museums, (and open like them freely to the inspection of the public,) a number of panoramas were established which represented in turn, the landscapes from different geographical latitudes, and from the different zones of the Earth. The idea of unity in Nature, and the feeling of harmony which pervades her works in "Kosmos," would become so much the more lively among men, as the means of representing natural phenomena, in characteristic pictures, are multiplied.

III. THE CULTIVATION OF TROPICAL PLANTS.—COMPARISON AND APPOSITION OF SPECIMENS.—THE IMPRESSION FROM THE PECULIARITY IN THE CHARACTER OF VEGETATION, AS FAR AS ANY SUCH IMPRESSION IS PRODUCED.

The effect of Landscape Painting, in spite of its multiplied production by means of copper-plates, and the most recent improvements in lithography, produces a more limited and less stirring impression upon a mind susceptible of the beauties of Nature, than the actual examination of exotic plants in hot-houses and gardens. I have already brought forward the experience of my own younger days; I have reminded my readers how the sight of a colossal dragon-tree, and a fan-leaved palm, in an old tower of the botanical garden at Berlin, implanted in me the first seeds of an irresistible desire for distant travelling. He who can actually recur in his memory to what gave the first motive to the whole direction of his life, will not fail to admit the influence of impressions upon the senses.

I here distinguish between the impression from the sight of a picturesque collection of plants, and the aid

obtained by the botanical examination of flowers; I distinguish the groups of plants, remarkable for their size and number (Pisangas, Heliconias, Corypha Palms, Araucarias and Mimosas; moss-covered stems, from which the fine-leaved ferns, the Dracontium, and flowering Orchideæ spring,) from a number of single lower specimens, which are arranged and cultivated according to their natural families, for instruction in descriptive and systematic botany. Our contemplation is here especially directed to the luxuriant development of vegetation in the Cecropias, Carolinas, and the feathery bamboos: to the picturesque arrangement of great and noble specimens, as they adorn the Upper Orinoco, or the banks of the river Amazon, and the Huallaga, so naturally described by Martius and Edward Pöppig; and to the impressions which fill the mind with a desire for visiting those distant regions where the stream of life flows more freely, and whose splendid productions provide for our hot-houses (hospitals for half-living and fermenting vegetable matter) their weak, but still pleasing inmates.

Landscape Painting certainly affords a richer and more perfect picture of Nature, than we can obtain from the artificial grouping of cultivated plants. It includes in its magic province, size and form; unconfined in space, it follows the border of the wood until it is lost in the misty distance; it represents the mountain-stream dashing from cliff to cliff, and the deep blue of a tropical sky, extended over the summits of the palms, and over the verdant horizon. The lights and colours which diffuse the brightness of a clear but slightly overcast tropical sky, give to landscapes, when the artist is fortunate in seizing

upon the natural effect, a peculiar and magic influence. With a deep knowledge of the essence of the Greek tragedy, the magic power of the chorus, as an effective means of communication, has been compared with the sky in the landscape (127).

The multiplication of the means of which the art of painting makes use, for the purpose of exciting the fancy, and of concentrating into a narrow space the grandest phenomena of sea and land, is denied to gardens and plantations; but although in the latter, the general impression of the picturesque is less, they indemnify themselves by the mastery always exercised by the senses over that which is real. If in the palm house of the "Peacock's Isle" (Pfaueninsel) at Potsdam, (a memorial of the simple love of Nature in our noble departed monarch), we look down from the high balcony, on a clear sunshiny day, upon the luxuriance of the shrubs and tree palms beneath, we are for the time deceived, and imagine ourselves in some distant region. We fancy that we are looking down from the top of a hill in a tropical country, upon a little thicket of palms. We certainly miss the view of the deep blue sky, and the impression of the greater intensity of the light; but still the imagination is here more active, and the illusion greater than in the most perfect pictures. We connect with each plant the wonders of some distant world; we see the changing and fading lights, when the summits of the palms, softly fanned by a gentle breeze, rustle against one another. So great is the charm which reality can create, even when the recollection of the requisite care and the artificial nature of hot-houses disturbs our associations. A perfectly thriving condition and

freedom are inseparable ideas in Nature, and for a zealous botanist who has visited distant regions, the dried plants of a "hortus siccus," when they have been gathered in the Cordilleras of South America, or in the plains of India, have frequently more worth than the same plants taken from an European hot-house. Cultivation destroys some of the original natural character, and disturbs and cramps the free development of the several parts.

The characteristic forms of plants, and the comparison and apposition of specimens, is not only a part of Natural History, or an inducement to its study; but the attention which is given to the *Physiognomy of Plants* is also of great importance for taste in gardening, *i. e.* for the art of composing a garden landscape. I here resist the temptation of examining this neighbouring field of inquiry, and content myself with reminding my readers that, as in the beginning of this work, we found occasion to prize the more frequent outbreak of a deep sense of Nature's beauties in Semitic, Indian, and Iranian people, so history exhibits to us the earliest parks and gardens in the middle and South of Asia. Semiramis had a garden laid out at the foot of the hill Bagistan, as Diodorus describes (128), the fame of which induced Alexander, upon his march from Celonæ to the Nysean pastures, to wander from his direct route. The parks of the Persian Kings were adorned with cypress trees, whose obelisk-like forms reminded them of flames of fire, and which were, therefore, planted by Guschtasp around the holy temple of fire, first after the appearance of Zerduscht (Zoroaster). Thus the forms of the trees themselves led to the fables of the origin of the Cypress from Paradise (129). The

Asiatic pleasure-gardens (παράδεισοι) were early famed in the West [130]. The worship of trees ascends among the Iranians, as far back as the precepts of the Hom, which in the Zend-avesta is called the propounder of the ancient law. We know, from Herodotus, the joy with which Xerxes viewed the great plane-trees in Lydia [131], which he presented with golden ornaments, and to which, in the person of one of his immortal band of ten thousand, he gave a separate sentinel. The ancient honour thus paid to trees was always connected, on account of the enlivening and cool shade of the foliage, with the worship of the holy fountains.

The fame among the Grecians of the wonderful palm-tree at Delos, and the old plane-tree in Arcadia, belong to this form of Nature-worship. The Buddhists at Ceylon, honour the colossal Indian fig-tree (Banyan) of Anurahdepura. It is said to have sprung from a branch of the original tree under which Buddha, an inhabitant of the ancient Magadha, sunk into blessedness (extinction, Nirwâna) [132]. Thus, single trees, on account of their beautiful form, became an object of sanctity; and groups of trees were called Groves of the Gods. Pausanias is full of the praise of a grove at Apollo's temple at Grynion, in Æolis [133]; that at Colonus was celebrated by the famous chorus of Sophocles.

A feeling for Nature made itself manifest in the choice and careful attention to objects of the vegetable kingdom, which they dedicated to religious purposes, and was seen in a more lively manner, and more frequently in the gardens of the earliest civilized inhabitants of East Asia. In the more distant parts of the Old Continent, the Chinese

gardens appear to have most nearly approached those which we have usually known under the title of English parks.

Under the victorious dynasty of Han, the public gardens were of so vast an extent that agriculture was impeded [134], and the people were excited to uproar. "What do we look for," says an old Chinese writer, Lieu-tscheu, "in the enjoyment of a pleasure-garden? In all countries it has been agreed that planting must be injurious to man, as far as anything agreeable is concerned, because it removes him to a distance from the free life of Nature, his proper and most delightful sphere. The art of laying out gardens consists in an endeavour to unite cheerfulness (of prospect), luxuriance of growth, shade, loneliness and quiet, so that the senses are deceived by the rural appearance. The great variety, the chief advantage of a free landscape, must be looked for in the choice of the ground, in the mixture of hills and deep valleys, of ponds and lakes which are covered with water-plants. All symmetry is wearisome. Disgust and tediousness are produced in gardens in which stiffness and art are visible [135]." A description which Sir George Staunton has given us of the great imperial garden at Zhe-hol [136], north of the great Chinese wall, corresponds with these rules of Lieu-tscheu, to which one of our talented cotemporaries, the projector of the lovely park at Moscow, will not refuse his approbation [137].

In the great descriptive poem in which the Emperor Kien-long, about the middle of the last century wishes to honour the famous Mand-shú city of residence, Mouk-den, and the graves of his forefathers, he manifests the greatest love to Nature as she exists in her freedom, and but partially improved by Art. The poetical ruler knew

how to unite the cheerful picture of the luxuriant freshness of the corn, of the wooded hills and peaceful abodes of Man, with the solemn scene of the burying-place of his forefathers. The offering which he makes to them, according to the rights described by Confucius, and the pious recollections of the departed monarchs and warriors, are the special subjects of this remarkable poetical production. A long account of wild plants, and of the beasts which inhabit the region is, like everything else didactic, very wearisome; but the interweaving of the sensible impressions of the landscape, which serves only as a back-ground to the picture, together with the exalted objects of the ideal world, with the fulfilment of religious duties, and the narration of great historical events, gives to the whole composition a very peculiar character. The holy feeling for the veneration of the hills, a feeling so deeply rooted in the Chinese people, leads Kien-long into careful delineations of the physiognomy of inanimate Nature, for which the Greeks and Romans had no taste. The form of the individual trees, the direction of their boughs, and the shape of their leaves, were all treated with great apparent love for his subject ([138]).

As I do not give way to feelings of aversion to the Chinese literature, which is, alas! too slowly disappearing amongst us, and as I have too long dwelt upon the natural taste of a cotemporary of Frederick the Great, I must so much the more ascend seven centuries and a half further back, to mention the "Garden Poem" of See-ma-kuang, a distinguished statesman. The places which the poem describes were partly full of buildings, after the manner of the old Italian villas; but the states-

man also sings of a hermitage which lies among the rocks, and is surrounded by high fir-trees. He praises the open view over the broad river Kiang, covered with vessels; he does not fear the visits of his friends, even when they come to read to him their poems, because they also listen to his (139). See-ma-kuang wrote about the year 1086, whilst in Germany the art of poetry was still in the hands of a rough priesthood, and had not once appeared in the language of the country.

At that time, and perhaps half a century earlier, the inhabitants of China, of the Indies, and of Japan, were already acquainted with a great variety of plants. The close connection which existed between the Buddhist monastic establishments, exercised its influence here. Temples, convents, and burial-places were surrounded by gardens, which were adorned with foreign trees, and a carpet of many-coloured and varied flowers. Indian plants were at an early date known in China, Corea, and Nipon. Siebold, whose writings afford a comprehensive view of all circumstances connected with Japan, was the first to draw attention to the cause of the intermixture of the flowers, in remote Buddhish countries (140).

The richness and number of the characteristic forms of plants which our age affords for scientific observation, as well as to the art of Landscape Painting, must in a lively way excite us to examine the sources which prepare for us this knowledge and pleasure in Nature. Their consideration is reserved for the next division of this work, "The History of the Examination of the World." Hitherto we have been occupied in delineating the inducements which, with the advance of civilization, have so powerfully

aided in exciting the study of Nature, in the reflection of the external world upon the mind of Man, upon his intellect, and his moral and perceptive faculties. The original power of organization, (in spite of a certain freedom in the development of individual parts), confines all the forms of the animal and vegetable kingdoms, to certain fixed and ever-recurring types; it determines in each zone its peculiar and distinct character, that is, the *Physiognomy of Nature.* Thus one of the fairest fruits of European civilization is, that it has placed it within Man's power, whenever he is impelled by strong desire, to obtain, by means of the cultivation and arrangement of exotic plants, by the charms of Landscape Painting, and by the help of spirited descriptions, a part of the pleasures in Nature's scenes, which real examination affords him, in long and frequently dangerous journeys through the centre of distant continents.

NOTES.

[1] (p. 2.)—Kosmos, vol. i. p. 52.

[2] (p. 3.)—The forms of the main-lands of Italy, Sicily, Greece, of the Caspian and Red Seas. *Vide* my "Relation historique du Voyage aux Régions équinoxiales," vol. i. p. 208.

[3] (p. 3.)—Dante, Purgatorio i. 25—28.

"Alas! How faintly gleams our northern pole,
Compared with these celestial orbs that roll
Their endless journey round the southern sky,
Half dazzled with their beams, I turned again
To spy the northern charioteer in vain,
The pole, and flaming guards escaped mine eye."

[4] (p. 4.)—Schiller's Entire Works, 1826, vol. xviii. p. 231, 473, 480 and 486; Gervinus, The Modern History of the National Poetical Literature among the Germans, 1840, vol. i. p. 135; Adolphus Becker, in Charicles, Pt. i. p. 219. Compare with these, Edward Müller, upon the Views of Nature in Sophocles, and the deep feelings for her beauties among the Greeks, 1842, p. 10 and 26.

[5] (p. 6.)—Schnaase, History of the Arts amongst the Ancients, vol. ii. 1843, p. 128—138.

[6] (p. 6.)—Plut. de EI apud Delphos, c. 9. Compare with the Account of a Passage of Apollonius Dyscolus of Alexandria. (Mirab. Histor. c. 40) the last Work of Otfried Müller: History of the Grecian Literature, vol. i. 1845, p. 31.

[7] (p. 6.)—Hesiodi Opera et Dies, v. 502—561; Göttling, in Hesiod. Carm. 1831, p. xix.; Ulricus, History of Grecian Poetry, Pt. i. 1835, p. 337; Bernhardy, Grecian Literature, Pt. ii. p. 176; however, according

to the opinion expressed by Gottfried Hermann (Opuscula, vol. vi. p. 239) "The artistic description of winter in Hesiod bears all the signs of high antiquity."

[8] (p. 6.)—Hesiod. Theog. v. 233—264. Also the Nereid Maera (Od. xi. 326, Il. xviii. 48) is probably intended to express the phosphorescent light upon the surface of the sea, as the same name μαῖρα represents the twinkling dog star (Sirius).

[9] (p. 7.)—Compare, Jacobs, Life and Art among the Ancients, vol. i. Pt. i. p. 7.

[10] (p. 8.)—Ilias viii. 555—559; iv. 452—455; xi. 115—199. Compare also at the beginning of the review of the army, the crowded but animated descriptions of the Animal Kingdom, ii. 458—475.

[11] (p. 8.)—Odyss. xix. 431—445; vi. 290; ix. 115—199. Compare "the shade of the verdant grove" in the rocky grotto of Calypso, "where an immortal himself would wait full of admiration, and heartily enjoy the prospect." v. 55—73; the raging of the waves in the country of the Phaeacians, v. 400—442; the Garden of Alcinous, vii. 113—130. Concerning the Dithyrambus upon Spring, *vide* Böckh, Pindari Opera, v. ii. Pt. ii. p. 575—579.

[12] (p. 9.)—Œdipus Coloneus, v. 668—719. As descriptions of the Landscapes, in which a deep sense for Nature's beauties is manifest, I must here mention: the delineation of the Cithaeron in the Bacchi of Euripides, v. 1045 (Leake, Northern Greece, vol. ii. p. 370), where the messenger mounts from the Valley of Asopus; the account of the rising of the sun, in the Valley of Delphi, in Euripides, Ion. v. 82; of the view of the Holy Delos, painted in dismal colours: "which the sea-gulls flutter round, and the stormy waves dash against," in Callimachus, in the Hymn upon Delos, v. xi.

[13] (p. 10.)—From Strabo (lib. viii. p. 366, Casaub.), where he complains of the tragic writer, on account of a geographical error with respect to the boundaries of Elis. The beautiful passage in Euripides is from Cresphontes, and the description of the eminence of Messena is closely connected with the account of its political relations (the division of the land under the Heraclidæ). The delineations of Nature were here also, as Böckh acutely remarks, viewed in their relation to man.

[14] (p. 11.)—Meleagri Reliquiæ, ed. Manso. p. 5. Compare Jacobs, Life and Art among the Ancients, vol. i. Pt. i. p. xv. Pt. ii. p. 150—190. Zenobetti (Mel. Gadareni in Ver Idyllion, 1759, p. 5) believed that he

first discovered the Spring poem of Meleager about the middle of the 18th century. *Vide* Brunckii Anal. t. iii. p. 105. Two beautiful forest poems by Marianus are in the Antholog. Græca, ii. 511 and 512. The praise of the spring in the Eclogues of Himerius, a Sophist, (a teacher of Rhetoric at Athens in the time of Julian), may be contrasted with the writings of Meleager. The style is, in general, cold and ornamented; but in particulars, especially in descriptive parts, he approaches very near to the modern method of contemplating the world. Himerii Sophistæ Eclogæ et Declamationes, ed. Wernsdorf. 1790 (Oratio iii. 3—6 and xxi. 5). We cannot but be surprised, that the splendid situation of Constantinople has not at all inspired the Sophist. (Orat. vii. 5—7,; xvi. 3—8). The passages of Nonnus, which are alluded to in the text (p. 11) are found in the Dionys. edit. Petri Cunæi, 1610, lib. ii. p. 70, vi. p. 199, xxiii. p. 16 and 619, xxvi. p. 694. (Compare also Ouwaroff, Nonnus of Panopolis, the Poet, 1817, p. 3—16, and 21).

15 (p. 12.)—Æliani Var. Hist. et Fragm. lib. iii. cap. i, p. 139, Kühn. Compare A. Buttmann, Quæst. de Dicæarcho (Naumb. 1832), p. 32, and Geogr. gr. min. ed. Gail, vol. ii. p. 140—145. A remarkable love for Nature's beauties, especially, a taste for flowers, as William Jones has observed and collected in the works of the Indian Poets, is seen in a Tragic Author, Chæremon; *vide* Welcker's Greek Tragedian, Pt. iii. p. 1088.

16 (p. 12.)—Longi Pastoralia (Daphnis and Chloe, ed. Seiler, 1843), lib. i. 9; iii. 12 and iv. 1—3; p. 92, 125 and 137. Compare Villemain sur les romans Grecs in his Mélanges de Littérature, t. ii. p. 435—448, where Longus is compared with Bernandin de St. Pierre.

17 (p. 12.)—Pseudo-Aristot. de Mundo, cap. 3, 14—20, p. 392, Bekker.

18 (p. 13.)—*Vide* Aristotle among the Romans, by Stahr, 1834, p. 173—177; Osann, Remarks upon the History of Grecian and Roman Literature, vol. i. 1835, p. 165—192. Stahr supposes (p. 172), with Heumann, that the Greek text of the present day is a reversed translation of the Latin text of Appuleius. The latter says distinctly that, (de Mundo, p. 250, Bip.) "In the composition of his work he has copied Aristotle and Theophrastus."

19 (p. 13.)—Osann, loc. cit. p. 194—266.

20 (p. 13.)—Cicero de Naturâ Deorum, ii. 37. A passage, in which Sextus Empiricus (adversus Physicos, lib. ix. 22, p. 554, Fabr.), quotes a

similar opinion of Aristotle, deserves all the more attention, because Sextus shortly before alludes to another text, which is also lost, (concerning Divination and Dreams).

[21] (p. 13.)—"Aristoteles flumen Orationis aureum fundens," Cic. Acad. Quæst. ii. cap. 38. (Compare Stahr, Aristotelia. Pt. ii. p. 161, and in the same work: Aristotle among the Romans, p. 53.)

[22] (p. 15.)—Menandri Rhetoris Comment. de Encomiis ex rec. Heeren. 1785, sect. i. cap. v. p. 38 and 39. The severe critic calls the didactic poem descriptive of Nature, ψυχρότερον, a "chilly" composition, in which the powers of Nature appear stripped of their personifications: Apollo is light; Juno the phenomena of the atmosphere; and Jupiter is warmth. Also Plutarch (de aud. poet. p. 27, Steph.) despises the so-called natural poems, which only have the form of poetry. According to the philosopher of Stagira, (de Poet. c. i.) Empedocles is rather a physiologist than a poet; he has nothing in common with Homer, except the metre of his verses.

[23] (p. 15.)—"It may appear wonderful that we wish to unite poetry, which delights especially in variety of forms and colours, with the most, simple and abstract ideas; but it is not the less correct. Poetry, Science, Philosophy and History are not, in their essence, distinct. They are one, wherever man's education is single, or where he has become part of that unity, by the possession of a truly poetical spirit."—William von Humboldt, Entire Works, vol. i. p. 98—102, (compare also Bernhardy, Roman Literature, p. 215—218, and Frederic Schlegel's Entire Works, vol. i. p. 108—110). Cicero (ad Quint. fratrem ii. 11) ascribed, if not morosely, at any rate with much severity, more art than creative talent (ingenium) to the works of Lucretius, so highly praised by Virgil, Ovid and Quintillian.

[24] (p. 15.)—Lucretius, lib. V. v. 930—1455.

[25] (p. 15.)—Plato, Phædr. p. 230; Cicero de Leg. i. 5. 15; ii. 2, 1—3, ii. 3, 6 (compare Wagner's Comment. perp. in Cic. de Leg. 1804, p. 6); Cicero de Oratore, i. 7, 28, (p. 15, Ellendt).

[26] (p. 16).—*Vide* the splendid work of Rudolph Abeken, the head of the school at Osnabrück, which appeared in the year 1835, under the title, "Cicero and his Letters," p. 431—434. The important addition respecting Cicero's birth-place is by H. Abeken, the learned nephew of the Author, at one time Chaplain to the Prussian Ambassador at Rome, now a companion in the important Egyptian expedition of Professor

Lepsius. Compare also concerning Cicero's birth-place, Valery, Voyage en Italie, vol. iii. p. 421.

27 (p. 16.)—Cicero, Epist. ad Atticum, xii. 9 and 15.

28 (p. 17.)—The passages of Virgil which Maltebrun adduces as descriptions of particular scenery (Annales des Voyages, vol. iii. 1808, p. 235—266) simply prove that the poet was acquainted with the productions of different countries; the saffron of Mount Tmolus, the frankincense of the Sabæans, the true names of many little rivers, and the mephitic vapours which rise out of some caverns in the Appenines at Amsanctus.

29 (p. 18.)—Virgil's Georgics, i. 356—392; iii. 349—380; Æneid, iii. 191—211: iv. 246—251; iv. 522—528; xii. 684—689.

30 (p. 18.)—*Vide* Kosmos, vol. i. p. 255 and 448. (Compare as separate pictures of Nature, Ovid, Met. i. 568—576; iii. 155—164; iii. 407—412; vii. 180—188; xv, 296—306; Trist. lib. i. El. 3, 60; lib. iii. El. 4, 49; El. 12, 15. Ex Ponto, lib. iii. Ep. 7—9). Among the rare examples of the description of particular scenes, such as refer to some certain landscape, we must mention, as Ross first pointed out, the lively delineation of a spring at Hymettus, beginning with the verse: "Est prope purpureos colles florentis Hymetti—" (Ovid, de arte am. iii. 687). The poet describes the spring Callia, so famous among the nations and dedicated to Venus, which bursts forth from the western side of the otherwise arid Hymettus. (*Vide* Ross, Letters to Professor Vuros, in the Grecian Medical Journal, June, 1837.)

31 (p. 19.)—Tibullus, ed. Voss, 1811, Eleg. lib. i. 6, 21—34; lib. ii. 1, 37—66.

32 (p. 19.)—Lucan, Phars. iii. 400—452, (vol. i. p. 374—384, Weber.)

33 (p. 19.)—*Vide* Kosmos, vol. i. p. 303.

34 (p. 19.)—*Vide* Op. cit. p. 450. The poem "Etna," by Lucilius, very probably a fragment of a larger work, concerning the remarkable natural productions and phenomena in Sicily, was ascribed to Cornelius Severus, by Wernsdorf. Special attention is due to the praise of the general study of Natural History, considered as "fruits of the genius," v. 270—280; the stream of lava, v. 360—370 and 474—515; the breaking out of the water at the foot of the volcano (?) v. 395. The formation of the pumice-stone, v. 425, (p. xvi—xx, 32, 42, 46, 50 and 55, ed. Jacob, 1826).

35 (p. 20.)—Decii Magni Ausonii Mosella, v. 189—199, p. 15 and

44, Böcking. Compare the Notice upon the Fishes of the Moselle, a treatise not unimportant in Natural History and acutely turned to account by Valenciennes, v. 85—150, p. 9—12, a companion to Oppian, (Bernhardy, Grecian Literature, Pt. ii. p. 1049). To this dry didactic species of poetry, which had for its subject the productions of Nature, the Ornithogonia and Theriaca of Emilius Macer of Verona, now lost, evidently belonged; they were written in imitation of the works of Nicander of Colophon. A natural description of the southern coast of Gaul contained in the poetical journal of Claudius Rutilius Numatianus, a statesman under Honorius, is more attractive than the Moselle of Ausonius. After the incursion of the Barbarians into Rome, Rutilius returned to Gaul to his estates. We possess unfortunately only a fragment of the second book, which does not lead us further than to the quarries of Carrara. *Vide* Rutilii Claudii Namatiani de Reditu suo (e Roma in Galliam Narbonensem) libri duo; rec. A. W. Zumpt, 1840, p. xv, 31 and 219, (with a beautiful map of Kiepert); Wernsdorf, Poetæ lat. min. t. v. Pt. i. p. 125.

[36] (p. 21.)—Tac. Annal. ii. 23—24; Hist. v. 6. The only fragment which the orator Seneca (Suasor. i. p. 11, Bipont.) has kept from an heroic poem in which Ovid's friend, Pedo Albinovanus sung of the deeds of Germanicus, describes the unlucky voyage upon the Ems (Ped. Albinov. Elegiæ, Amsterd. 1703, p. 172). Seneca considers this delineation of the stormy sea, to be more artistic than anything which the Roman poets have produced. Indeed, he says himself, "latini declamatores in Oceani descriptione non nimis viguerunt; nam aut tumide scripserunt aut curiose."

[37] (p. 21.)—Curt. in Alex. Magno vi. 16. (Compare Droysen, History of Alexander the Great, vi. 16, 1833, p. 265.) In the somewhat too oratorical Lucius Annæus Seneca (Quæst. Natur. lib. iii. c. 27—30, p. 677—686, ed. Lips. 1741), there is a remarkable description of the destruction of the human race, (at first pure, but afterwards sinful) by means of an universal deluge: "Cum fatalis dies diluvii venerit...." as far as: "peracto exitio generis humani extinctisque pariter feris in quarum homines ingenia transierant...." Compare the delineations of the changes of chaos, and the revolutions of the earth in the Bhagavata-Purana, book iii. chap. xvii. (ed. Burnouf, vol. i. p. 441.)

[38] (p. 22.)—Plin. Epist. ii. 17; v. 6; ix. 7; Plin. Hist. nat. xii. 6; Hirt, History of Agriculture among the Ancients, vol. ii. p. 241, 291 and

376. The Villa Laurentina of the younger Pliny was near the present Torre di Paterno, in the Valley la Palombara, on the coast east of Ostia; *vide* Viaggio da Ostia a la Villa di Plinio, 1802, p. 9, and Le Laurentin, by Haudelcourt, 1838, p. 62. The few following lines which Pliny wrote from Laurentinum to Minutius Fundanus, contains the expression of deep feeling for Nature: "Mecum tantum et cum libellis loquor. Rectam sinceramque vitam! dulce otium honestumque! O mare, o littus, verum secretumque μουσεῖον! quam multa invenitis, quam multa dictatis!" (I. 9). Hirt was convinced that, when the strict and regular art of gardening appeared in Italy, (which was early called the French mode, and was opposed to the free and picturesque English method), the cause of this earlier inclination to dull and regular prospects was to be found in the desire of imitating as closely as possible the description which Pliny the younger had given in his letters. (History of Agriculture among the Ancients, Pt. ii. p. 366).

[39] (p. 23.)—Plin. Epist. iii. 19; viii. 16.

[40] (p. 23.)—Suet. in Julio Cæsare, cap. 56. The last work of Cæsar (Iter) described the journey to Spain, which, in his last Campaign he performed according to Suetonius in twenty-four, according to Strabo and Appian in twenty-seven days by land from Rome to Corduba, because the remains of Pompey's party, which had been conquered in Africa, had again collected together in Spain.

[41] (p. 23.)—Sil. Ital. Punica, lib. iii. v. 477.

[42] (p. 23.)—*Vide* Op. cit. lib. iv. v. 348, lib. viii. v. 399.

[43] (p. 24.)—*Vide* Nicholas Bach in the general School Journal upon the Elegiac Poems, 1829, Pt. ii. No. 134. p. 1097.

[44] (p. 25.)—Minucii Felicis Octavius, ex rec. Gron. (Roterod. 1743), cap. 2 and 3 (p. 12—28), cap. 16—18 (p. 151—171).

[45] (p. 25.)—Concerning the Death of Naucratius about the year 357, *vide* Basilii Magni Op. omnia ed. Paris, 1730, v. iii. p. xlv. The Jewish Essenes led hermits' lives on the western bank of the Dead Sea two hundred years before our Era, "in intercourse with Nature." Pliny says of them (v. 15): "Mira gens, socia palmarum." The Therapeutæ lived originally, and with more of the sociableness of a convent life, in a charming region upon the Sea of Mœris (Neander, General History of the Christian Religion and Church, vol. i. Pt. i. 1842, p. 73 and 103).

[46] (p. 26.)—Basilii Mag. Epist. xiv. p. 93, Ep. ccxxiii, p. 339. Concerning the beautiful letter to Gregory Nazianzen, and the poetical dispo-

sition of Saint Basil, *vide* Villemain de l'éloquence chrétienne dans le quatrième siècle, in his 'Mélanges historiques et littéraires,' vol. iii. p. 320—325. The Iris, upon whose banks the family of the great Basil possessed an ancient estate, arises in Armenia, runs through the picturesque region of Pontus, and mixing with the Lycus, empties itself together with that river into the Black Sea.

[47] (p. 27.)—Gregory Nazianzen, however, did not permit the description of St. Basil's hermitage upon the Iris to allure him; he preferred Arianzus in the region of the Tiber, although his friend morosely called this place a dirty 'βάραθρον' (a pit.) St. Basil, Epist. ii. p. 70, and the Life of St. Basil, p. 46 and 59 of the edition of 1730.

[48] (p. 27.)—Basilii Homil. in Hexæm. vi. i. and iv. 6. (Bas. Opp. omnia ed. Jul. Garnier, 1839, vol. i. p. 54 and 70). Compare with this the expression of deep melancholy in the beautiful poem of Gregory Nazianzen, under the title "of the Nature of Man." (Greg. Naz. Op. omnia edit. Paris, 1611, vol. ii. Carmen xiii. p. 85).

[49] (p. 28.)—The passage of Gregory of Nyssa quoted in the text, is collected from separate fragments brought together and literally translated. They are found in S. Gregorii Nysseni, Op. edit. Paris, 1615, vol. i. p. 49 C, p. 589 D, p. 210 C, p. 780 C; vol. ii. p. 860 B, p. 619 B, p. 619 D, p. 324 D. "Deal gently with the emotions of Melancholy," says Thessalius in the mottos which were so much admired by his cotemporaries. (Bibliotheca; Patrum. ed. Par., 1624, vol. ii. p. 1180 C).

[50] (p. 28.)—St. Johannis Chrysostomi, Opp. omnia Par., 1838, (8vo.) vol. ix. p. 687 A, vol. ii. p. 821 A and 851 E, vol. i. p. 79. Compare also Johannis Philoponi in cap. i. Geneseos de creatione Mundi, libri septem Viennæ Austr. 1630, p. 192, 236 and 272; as also Georgii Pisidæ Mundi opificium, ed. 1596, v. 367—375, 560, 933 and 1248. The works of Basil and Gregory Nazianzen had, at an early date, since I began to collect together descriptions of natural scenes, attracted my attention; but, for all the excellent translations of Gregory of Nyssa, Chrysostom. and Thalassius, which I have brought forward, I have to thank my old and benevolent colleague and friend, Mr. Hase, Member of the Institute, and Conservator of the Royal Library at Paris.

[51] (p. 29.)—Concerning the Concilium Turonense under Pope Alexander III., *vide* Ziegelbauer; Hist. Rei litter. ordinis S. Benedicti, vol. ii. p. 248, ed. 1754; of the council at Paris of 1209, and the Bull of Gregory IX. of the year 1231, *vide* Jourdain, Recherches critiq. sur les

traductions d'Aristote, 1819, p. 204—206. To read the works of Aristotle upon Physics was visited with severe punishment. In the Concilium Lateranense of 1139, (Sacror. Concil. nova Collectio, ed. Ven. 1776, vol. xxi. p. 528), the practice of medicine was forbidden to the monks. Compare the learned and animated work of the younger Wolfgang by Gœthe, 'Man and the Elements of Nature,' 1844, p. 10.

[52] (p. 31.)—Fred. Schlegel upon Northern Poetry, in his Entire Works, vol. x. p. 71 and 90. From the very early times of Charles the Great, there is still extant the poetical description of the wooded and cultivated park near Aix la Chapelle, in the time of the Great Emperor, by Angilbertus, Abbot of St. Riquier, (*vide* Perz. Monum. vol. ii. p. 393—403).

[53] (p. 32.)—*Vide* the comparison of the two Epic Poems, the Nibelungen (representing the revenge of Chriemhild, the wife of Siegfried), and the Gudrun (the daughter of King Hetel) in Gervinus, 'History of German Literature,' vol. i. p. 354—381.

[54] (p. 33.)—For an account of the Romantic Cave of the Lovers, in the Tristan of Godfrey of Strasburgh, *vide* Gervinus, op. cit. vol. i. p. 450.

[55] (p. 34.)—Vridankes Intelligence, by William Grimm, 1834, p. 50 and 128. I have borrowed all the sentence about the German Epic Poem, and the Songs of the Minstrels (in the text, from p. 31 to 34), from a letter from William Grimm to me (Oct. 1845). From a very old Anglo-Saxon poem concerning the Runic names, which Hickes first published, and which has a certain connection with the Eddian Songs, I here quote a very characteristic description of a birch-tree: "Beor. is beautiful in the branches; on the summits she rustles sweetly with the leaves, moved by the breezes." The greeting of the day is simple and noble, "Day is the messenger of the Lord, dear to man, the glorious light of God, joy and peace to rich and poor, beneficial to all!" Compare William Grimm, über Deutschen Runen, 1821, p. 94, 225 and 234.

[56] (p. 35.) Jacob Grimm on Reinhard Fuchs, 1834, p. 294. (Compare also Christian Lassen in his account of Indian Antiquity, vol. i. 1843, p. 296).

[57] (p. 36.)—The spuriousness of Ossian's Songs, and of Mac-Pherson's Ossian especially, by Talvi, (1840), the talented Authoress of the translation of the Servian popular poetry. The first publication of Ossian by Mac-Pherson was in 1760. The Finnian Songs certainly

resound from the highlands of Scotland, as well as from Ireland, but according to O'Reilly and Drummond, they were imported from Ireland to Scotland.

[58] (p. 36.)—Lassen, Indian Antiquity, vol. i. p. 412—415.

[59] (p. 37.)—Concerning the Indian hermits in the woods, the Vanaphrastes, (sylvicolæ) and the Sramani (a name which has been changed into Sarmanians and Garmanians), *vide* Lassen, "de nominibus quibus veteribus appellantur Indorum philosophi," in the 'Rhenish Museum for Philology,' 1833, p. 178—180. William Grimm discovers an Indian colouring in the description of the woods, which the priest Lambrecht, 1200 years ago, gives in his 'Alexandrina Song' which is composed after a French pattern. The hero comes into a wonderful wood, where maidens adorned with all the charms of beauty grew out of the large flowers. He remained with them until the flowers and the maidens withered. (Compare Gervinus, vol. i. p. 282, and Massmann's Monuments, vol. i. p. 16). These are the maidens from Edrisi's eastern magic isle Vacvac; they are an article of exportation, and in the Latin translation of Masudi Chothbeddin are called "Puellæ vasvakienses." (Humboldt, Examen critique de la Géographie, vol. i. p. 53).

[60] (p. 38.)—Kalidasa, at the court of Vikramaditya, lived about fifty-six years before our era. The age of both the heroic poems, the Ramayana and the Mahabharata, most probably reaches far beyond the appearance of Buddha, *i. e.* far before the middle of the sixth century before the Christian era. (Burnouf, Bhagavata-Purana, vol i. p. 111 and 118; Lassen's Indian Antiquity, vol. i. p. 356 and 492.) George Forster, by his translation of Sakuntula, *i. e.* by his tasteful German version of the English translation of William Jones, (1791) has much added to the enthusiasm which then for the first time arose in Germany on the subject of Indian poetry. I willingly here quote the four beautiful lines of Göthe which appeared in 1792:

"Wilt thou understand the blooming of the early year, and the fruits of Autumn,
Wilt thou perceive that which pleases and delights, and that which satisfies and nourishes,
Wilt thou include the Heavens and the Earth in one name;
I name thee, Sakuntala, and have thus named everything."

The newest German translation of the Indian Drama, according to

the important original text, discovered by Brockhaus, is that by Otto Böhtlingk (Bonn, 1842.)

[61] (p. 38.)—Humboldt upon Moors and Deserts, in the Views of Nature, 2nd edition, 1826, vol. i. p. 33—37.

[62] (p. 39.)—In order to render the titles that are inserted in the text concerning Indian literature, perfectly intelligible, and to be able to give the sources of each (as we did before in the Grecian and Roman Literature) I here quote the "General Considerations of the Indian taste for Nature," communicated in manuscript by the most distinguished and philosophical professor of Indian Poetry, my friend, M. Theodor Goldstücker:

"Of all the causes which have increased the intellectual development of the Indian people, *that* has appeared to me to be the first and most important which has been exercised by the rich nature of the country upon the mind of the people. The deepest feeling for Nature's beauties has upon all sides affected their genius. We may adduce three epochs in reference to the modes in which this feeling has manifested itself. Each of them has its distinct character deeply rooted in the life and habits of the people. Hence, a few examples will suffice to show the activity of the Indian imagination for nearly three thousand years. The Vedas show the first age of the expression of a lively feeling for the beauties of scenery. From the Rigveda, we may mention the simple and elevated delineations of the morning sky (Rigveda-Sanhità, ed. Rosen 1838, hymn. xlvi. p. 88, hymn. xlviii. p. 92, hymn. xcii. p. 184, hymn cxiii. p. 233; compare also Höfer, Indian poems, 1841, Pt. 1. p. 3,) and the "golden-handed" sun (*vide* loc. cit. hymn,. xxii. p. 31, hymn xxxv. p. 65). The honouring of Nature was here, as in other nations, the beginning of their belief; but in the Vedas, she had this special character, that Man already considered her as most deeply connected with his external life and his inner feelings. The second epoch was very different. In it, a popular mythology was discernible; its object was to accomplish the traditions of the Vedas, and to interweave them with historical events, which are thus exalted into the region of fables. In this second epoch, we find the two heroic poems Ramayana and Mahabharata, of which the latter, the most recent, has the additional object of making the caste of Brahmins the most influential among the four, which constitute the state of Ancient India. Ramayana is more beautiful and richer in feeling for Nature; it has remained upon the territory of poesy, and has

not been compelled to include elements which are strange, or almost opposed to it. In both poems Nature is, no more than in the Vedas, the entire subject, but only a part of it. Two points distinguish the apprehension of Nature in this epoch of the heroic poems from that which is represented in the Vedas, without including the difference in the form which separates the language of adoration from that of a narrative. One point is the reality of its local description of Nature (for example, in Ramayana, by William von Schlegel, 1st book, on Balakanda, and the 2nd book on Ayodyakanda; *vide* also Lassen, upon the differences of these two great epic poems, in his 'Indian Antiquity,' vol. i. p. 482); the other point, closely connected with the first, is respecting the places which excite this feeling for the picturesque. The traditions and the historical portions have had the effect of substituting an account of certain localities in the place of general descriptions. The writers of the great epic poems, whether it was Valmiki, who sings of the deeds of Rama, or whether they were the authors of the Mahabharata, whom tradition has united under the general name of Vyasa, all indicate that in their narratives they were almost overcome by their feeling for Nature. The journey of Rama from Ayodhya, to the city of residence Janaka, his life in the woods, his departure for Lanka (Ceylon) where the wild Ravana, the ravisher of his wife Sita, dwelt, afford the ingenious poet, as did the hermit life of the Panduides, an opportunity to follow the original bent of the Indian spirit, and to connect the account of the deeds of heroes with the pictures of a rich country (Ramayana, ed. Schlegel, lib i. c. 26, v. 13—15, lib. ii. cap. 56, v. 6—11; compare Nalus, ed. Bopp. 1832, Ges. xii. v. 1—10). Another point, in which, with regard to natural taste, this second epoch differs from that of the Vedas, is the richer contents of the poetry itself. It is no longer, as before, the appearance of the heavenly powers; it includes rather the whole of Nature, the heavens and the earth, the world of plants and animals in its luxuriance and with its influence upon the mind of Man. In the third epoch of the poetical literature of India (with the exception of the Puranian, which are for the purpose of advancing religion in a sectarian spirit) Nature exercises unlimited sway; but the descriptive part of the poem is founded upon scientific and local observations. To name some of the great works which belong to this epoch, we may mention the Bhattikavya, that is, the Poem of Bhatti, which, like the Ramayana, has for its subject

the exploits of Rama, and in which exalted delineations of the life in the forests, during a banishment, accounts of the sea and its lovely shores, and of the daybreak in Lanka, follow one another in succession, (Bhattikavya. ed. Calcut. Pt. i. Cant. vii. p. 432, Cant. x. p. 715, Cant. xi. p. 814; compare Schütz, Professor at Bielefeld, Five Cantos of Bhatti kavya, 1837, p. 1—18); we may mention the Sisupalabadha of Magha, with its attractive account of the times of the day; the Naischada-Jarita of Sri Harja, where, however, in the History of Nalus and of Damayanti, the expression of natural feeling is lost in the metre. With this metre, the beautiful simplicity of Ramayana contrasts, when, for example, Visvamitra takes his pupil to the banks of the Sona (Sisupalabadha, ed. Calc. p. 298 and 372. Compare Schütz. op. cit. p. 25—28; Naischada-Jarita, ed. Calc. Pt. i. v. 77—129; Ramayana, ed. Schlegel, lib. i. cap. 35, v. 15—18). Kalidasa, the celebrated Author of the Sakuntala, is a masterly describer of the influence which Nature exercises upon the minds of lovers. The scene in the forest, which he introduced in the drama of Vikrama and Urvasi, is one of the most beautiful and poetical productions which have appeared in any time. (Vikramorvasi, ed. Calc. 1830, p. 71, translated in Wilson's Select Specimens of the Theatre of the Hindus, Calc. 1827, vol. ii. p. 63). In the poem of the Seasons, especially the account of the racing season and the spring (Ritusanhâra, ed. Bohlen, 1840, p. 11—18 and 37—45, Translation by Bohlen, p. 80—88 and p. 107—114), as in the "Messenger of the Clouds" (all being works of Kalidasa), the influence of scenery upon the mind of man, is again the chief subject of the composition. The Messenger of the Clouds (Meghaduta), edited by Wilson and Gildemeister, and also translated by Wilson and Chézy, pictures the grief of the banished upon the hill Ramagiri. In his longing after his loved one, from whom he is separated, he prays a cloud that is gathering over him, to give her an account of the cause of his pain. He lays down for the cloud, the way which it must follow, and paints the landscape as it is reflected in a deeply roused spirit. Among the treasures which Indian poetry in this third period owes to the taste of the people, I must especially cite the Gitagovinda of Jayadeva. (Rückert in the Journal of the East, vol. i. 1837, p. 129—173; Gitagovinda Jayadevæ poetæ Indici drama lyricum, ed. Chr. Lassen, 1836). We possess Rückert's masterly rhythmical translation of this poem, one of the most lively and most difficult of all

their literature; this translation gives the spirit of the original with wonderful truth, and shows the love of Nature which thoroughly pervades all the parts of this great composition."

[63] (p. 40.)—Journal of the Royal Geographical Society of London, vol. x. 1841, p. 2—3; Rückert, Makamen Hariri's, p. 261.

[64] (p. 40.)—Goethe in his Commentary to the Western and Eastern Divan, in his works, vol. vi. 1828, p. 73, 78 and 111.

[65] (p. 41.)—*Vide* le Livre des Rois publié par Jules Mohl, vol. i, 1838, p. 487.

[66] (p. 41.)—Compare in Jos. von Hammer, History of the beautiful Oratory of the Persians, 1818, p. 96, Ewhadeddin Enweri in the 12th century, in whose poems upon Jedshai, it is imagined that a remarkable allusion to the mutual attraction of the heavenly bodies has been discovered; p. 183 Jelaleddin, Rumi the Mysterious; p. 259 Jelaleddin Adhad; and p. 403 Feisi, who appears at the Court of Akbar, as the defender of the Religion of Brahma, and in whose Ghasele an Indian tenderness of the feelings is evident.

[67] (p. 41.)—"The night appears when the ink-horn of the sky is overturned," sings the tasteless Chodjah Abdullah Wassaf, who, however, has the credit of first having described the great observatory of Meragha with its lofty dial. Hilali from Asterabad makes "the disc of the moon glow with heat," and thus considers the dew as "the sweat of the moon." (Jos. von Hammer, p. 247 and 371).

[68] (p. 41.)—Tûirja, or Turan, are names, the origin of which is not known. Still Burnouf (Yaçna, vol. i. p. 427—430), ingeniously alludes to the Bactian Satrapy, called Turiua, or Turiva, in Strabo (lib. xi. p. 517, Cas.) Du Thiel and Groskurd (the latter, Pt. ii. p. 410), read Tapyria.

[69] (p. 42.)—On a Finnish Poem, by Jacob Grimm, 1845, p. 5.

[70] (p. 45.)—I have followed in the Psalms, the splendid translation of Moses Mendelssohn, (*vide* his Entire Works, vol. vi. p. 220, 238 and 280). Noble imitations of the old Hebrew poetry is found in the 11th century, in the Hymns of the Poet of the Spanish Synagogue, Solomon ben Jehudah Gabirol, which contain a poetical paraphrase of the Pseudo-Aristotelian work, "Upon the World," *vide* Michael Sachs, the Religious Poetry of the Jews in Spain, 1845, p. 7, 217 and 229. Also the pictures taken from the life of Nature in Moses Jacob ben Esra, are full of power and grandeur (p. 69, 77 and 285).

71 (p. 46.)—The passages of the Book of Job have been borrowed from the translation and exposition by Umbreit (1824), p. xxix—xlii., and 290—314. (Compare altogether, Gesenius, History of the Hebrew language and writings, p. 33, and Jobi Antiquissimi carminis hebr. natura atque virtutes, ed. Ilgen, p. 28). The longest and most characteristic description in Job (xl. v. 25—xli. v. 26) is that of the crocodile; and still in this part (Umbreit, p. 41. and 308), one of the proofs that the Author of the Book of Job was born in Palestine, is contained. As the hippopotamus and crocodile were at that time found in the Delta of the Nile, we need not wonder that an acquaintance with such rare animals had spread into the neighbouring country of Palestine.

72 (p. 47.)—Goethe in the Commentary and the Western and Eastern Divan, p. 8.

73 (p. 47.)—Antar, a Bedouin Romance, translated from the Arabic by Terrick Hamilton, vol. i. p. 26; Hammer in the Vienna Journal of Literature, vol. vi. 1819, p. 229; Rosenmüller on the character of the most distinguished poets in all nations, vol. v. (1798), p. 251.

74 (p. 48.)—Antara cum schol. Sunsenii, ed. Menil, 1816, v. 15.

75 (p. 48.)—Amrulkeisi Moallakat, ed. E. G. Hengstenberg, 1823; Hamasa, ed. Freytag, Pt. i. 1828, lib. vii. p. 785. Compare the poetical work, Amrilkais, the Poet and King, translated by Rückert, 1843, p. 29 and 62, where the rainy seasons are described twice with great truth. The royal poet visited, many years before the birth of Mohammed, the Court of Emperor Justinian, in order to beg help against his enemies. *Vide* the Diwan d'Amro'lkaïs, accomp. d'une traduction, par le Baron Mac. Guckin de Slane, 1837, p. 111.

76 (p. 48.)—Nabeghah Dhobyani in Silvestre de Sacy, Chrestom. Arabe, 1806, vol. iii. p. 47. Compare Weil upon the earlier Arabian Literature in general: the Poetical Literature of the Arabians before the time of Mohammed, 1837, p. 15 and 90, and also Freytag's description of Arabian Versification, 1830, p. 372—392. A splendid and complete translation of the Arabian Natural Poetry from Hamasa, may soon be expected from our great Poet, Frederic Rückert.

77 (p. 48.)—Hamasæ carmina, ed. Freytag, Pt. i. 1828, p. 788. Here is finished, as it says expressly, p. 796 "The chapter upon journeys and sleepiness."

[78] (p. 50.)—Dante, Purgatorio. Canto i. v. 115.

> "Flies the morning twilight grave,
> At the dawn's bright rosy car,
> While the tumult of the waves,
> I gazed at from afar."

[79] (p. 50.)—Purg. Canto v. v. 109—127.

> "Thou knowest how the vapour,
> Which at touch of cold at even
> Falls to the earth in moisture,
> Floats pendant in mid heaven."

[80] (p. 50.)—Purg. canto xxviii. v. 1—24.

[81] (p. 50.)—Paradis. canto xxx. v. 61—69.

> "I saw as 'twere a river
> With clouds to the left and right
> Splendid like radiant silver
> A flood—a stream of light.
> Angels of light rose shining
> From the wond'rous silvery river
> While an arch—like a rainbow spanning
> Of spirits girt them ever.
> As inebriate with sweet odour
> They plunged back in the light stream,
> While one its waves sank under
> One sprang forth like a moonbeam."

Compare the translation by the gifted poet and artist, Augustus Kopisch, 1842, p. 399—401. I have extracted nothing from the cantos of the 'Vita Nuova,' for the allegorical representations and pictures which it contains do not belong to the purely natural circle of earthly phenomena.

[82] (p. 51.)—I here remember the sonata of Bojardo: Ombrosa selva, che il mio duolo ascolti......" and the beautiful stanzas of Vittoria Colonna which follow:

> "When I beheld the earth
> Adorned in all her bowers
> With fruits of sweetest worth
> With a thousand scented flowers."

A beautiful and very particular description of the scenery of the estate of Fracastoro, on the Hill of Incassi (Mons Caphius) near Verona, is given in the works of this author, so distinguished as physician, mathematician and poet in his "Naugerius de poetica dialogus." (Hieron. Fracastorii, Opp. 1591, Pt. i. p. 321—326). Compare also in his didactic poem, lib. ii. v. 208—219 (Opp. p. 636) the lively passage about the cultivation of the citron in Italy. With astonishment I observe, upon the contrary, the absence of all expression of feeling for Nature in the letters of Petrarch; even though in 1345, therefore three years before the death of Laura, he attempted from Vaucluse to ascend Mount Ventoux, and anxiously hoped to look over into his native country, or though he, visited the banks of the Rhine as far as Cologne, or the Gulf of Baia. He lived rather in his classical recollections of Cicero and the Roman poets, or in the inspired depth of his ascetic melancholy, than in the beauties of Nature around him. (*Vide* Petrarch. Epist. de Rebus familiaribus, lib. iv. 1; v. 3 and 4; p. 119—156 and 161, ed. Lugdun. 1601). The description of a great storm which Petrarch noticed in Naples in 1343 (lib. v. 5, p. 165) is, however, very artistic.

83 (p. 53.)—Humboldt, Examen critique de l'histoire de la Géographie du Nouveau Continent, vol. iii. p. 227—248.

84 (p. 55.)—*Vide* supra, Kosmos, vol. i. p. 301 and 462.

85 (p. 55.)—Journal of Columbus upon his first voyage, October 29, 1492, November 25—29, December 7—16, December 21), also his letters to Doña Maria de Guzman, nurse of Prince Don Juan, December 1500 in Navarrete, "Collection of Voyages which the Spaniards made by sea," vol. i. p. 43, 65—72, 82, 92, 100 and 266.

86 (p. 56.)—Op. cit. p. 303—304 (Map of the Admiral of the King, written in Jamaica, July 7, 1503,) Humboldt, Examen crit. vol. iii. p. 231—236.

87 (p. 56).—Tasso, canto xvi. stanzas 9—16.

88 (p. 56.)—*Vide* Frederic Schlegel's Entire Works, vol. ii. p. 96, and concerning the wonderful duality of the mythology, the mixture of ancient fables with Christian views, vol. x. p. 54. Camoens, in the stanzas 82—84 which have not been sufficiently noticed, attempts to explain this mythical duality. Tethys confesses in a very simple way, but still in the most poetical manner: "that she herself, like Saturn, Jupiter, and all the crowd of Gods, are vain fables, which blind error produced for mortals; they only serve to give charm to songs. A Sancta Providencia que em Jupiter aqui se representa...."

[89] (p. 57.)—Os Lusiadas de Camões, canto i. v. 19, canto vi. v. 71—82. *Vide* also the simile in the beautiful description of the storm raging through the wood. Canto i. v. 35.

[90] (p. 57.)—The fire of St. Elms: "O lume vivo, que a maritima gente tem por santo, em tempo de tormenta...." canto v. v. 18. One flame, (Helena of the Grecian navigators) brings misfortune, (Plin. ii. 37); two flames, Castor and Pollux) appearing with a noise "like the flapping of wings," are signs of safety (Stob. Eclog. phys. i. p. 514; Seneca, Nat. Quæst. i. 1.) Concerning the high degree of peculiar life in his natural descriptions; *vide* the great Paris edition of 1818 in the Life of Camoens by Dom Joze Maria de Souza, p. cii.

[91] (p. 58.)—The water-spout (Wettersäule) canto v. est. 19—22, may be compared with the very poetical and natural description of Lucretius, vi. 423—442. Respecting the fresh water which comes down at the end of the phenomenon, apparently from the upper part of the water-spout, *vide* Ogden on Water-spouts (from Observations made during a voyage from the Havannah to Norfolk in the year 1820) in Silliman's American Journal of Science, vol. xxix. 1836, p. 254—260.

[92] (p. 58.)—Canto iii. v. 7—21. In the text of Camoens, I always follow the Editio Princeps of 1572, which has been restored to us in the beautiful and splendid edition of Don Joze Maria de Souza-Botelho (Paris, 1818). In the German quotations, I have chiefly followed the translation of Donner (1833). The principal object of the Lusiades of Camoens was the glory of his nation. It would be a monument worthy of so distinguished a poet, and of so great a nation, if, after the noble example shewn in the saloons of Schiller and Göthe in the grand ducal Castle at Weimar, in Lisbon itself the twelve grand compositions of my talented departed friend Gerard, which adorn Souza's edition, were painted as frescos in large size upon some well-lighted wall. The Vision of the King Dom Manuel, in which the Indus and the Ganges appear to him, the Giant Adamastor floating upon the Cape of Good Hope, ("Eu sou aquelle occulto e grande Cabo, A quem chamais vós outros Tormentorio"), the Murder of Ignes de Castro and the lovely Ilha de Venus, would have a grand effect.

[93] (p. 58.)—Canto x. v. 79—90. Camoens, like Vespucci, calls the parts of the southern sky nearest to the south-pole, "Poor in Stars." Canto v. v. 14. He also knew the existence of ice in the South Sea. Canto v. v. 27.

[94] (p. 58).—Canto x. v. 91—141.

[95] (p. 59.)—Canto ix. v. 51—63. (Compare Ludwig Kriegk, *Writings* upon General Geography, 1840, p. 338. The entire island, Ilha de Venus, is an allegorical fable, as it was expressly pointed out in verse 89. Only the beginning of the narration of Dom Manuel's Dream, delineates an Indian hill and wood scenery, canto iv. v. 70.

[96] (p. 60.)—Out of love for the old Spanish Literature, and for the charming climate in which the Araucana of Alonso de Ercilla y Zuñiga was composed, I have conscientiously twice read through the Epic Poem, 42,000 verses long; once in Peru, the other time, more recently in Paris, when, by the kindness of a learned traveller, M. Ternaux-Compans, I had a rare book, the nineteen songs of Arauco Conquered, composed by the *Licentiate* Pedro de Oña, Nature of los Infantes of Engol in Chili, printed in Lima in 1596 for the sake of comparing with Ercilla. Of the Epic Poem of Ercilla, which Voltaire calls an "Iliad," Sismondi "a newspaper in rhyme," the first 15 cantos were composed between 1555 and 1563, and had appeared by 1569: the last were printed in 1590, only six years before the wretched poem of Pedro de Oña, which has the same title as that of the dramatic masterpiece of Lope de Vega, in which the Cacique Caupolican again plays the chief part. Ercilla is simple and truehearted, especially in those parts of his composition, which, for want of paper, on the field of battle, he wrote upon the bark of trees, and the skin of beasts. The delineation of his thirst, and the ingratitude which he experienced at the hands of King Philip, is particularly moving, especially at the end of the 37th Canto.

"Climas passè, mudè constelaciones,
Golfos inavegables navegando,
Estendiendo, Señor, Vuestra Corona
Hasta la austral frigida zona...."

"The flower of my life is passed; I shall, with my late experience, renounce mortality, I shall weep and no more sing." The descriptions of Nature (the Garden of Magician, the storm which Eponamon raises, the description of the sea; Pt. i. p. 80, 135, and 173; Pt. ii. p. 130 and 161, in the edition of 1733) are without any feeling; the lists of geographical terms (Canto xxvii.) are so crowded together, that in one verse of eight lines, twenty-seven proper names follow immediately one upon another. The 2nd Part of the Araucana is not by Ercilla, but is a

continuation in 20 Cantos by Diego de Santistevan Osorio, following the 37 Cantos of Ercilla, and attached to them.

[97] (p. 60.)—In the Romancero de Romances caballeroscos é historicos ordenado por D. Augustin Duran, Pt. i. p. 189, and Pt. ii. p. 237, I think of the beautiful lines: "Yba declinando el dia—Su curso y ligeras horas...., and about the flight of King Rodrigo, which begins:

> "And the painted birds ceased singing,
> And the earth stood attentive listening
> To the river's gentle murmuring."

[98] (p. 60.)—Fray Luis de Leon, Obras proprias y traducciones dedicadas á Don Pedro Portocarero, 1681, p. 120: Noche serena. A deep feeling for the beauties of Nature is sometimes discernible in the old mystic poetry of Spaniards (Fray Luis de Granada, Santa Teresa de Jesus, Malon de Chaide); but the pictures of Nature are chiefly a mere covering by which the ideal religious notions are symbolized.

[99] (p. 61.)—Calderon in the 'Noble Prince' concerning the approach of the Spanish Fleet, Act. i. Scene i., and about the Kingdom of the Wild Animals in the forests, Act. iii. Scene 2.

[100] (p. 62.)—That which, in the opinion I have expressed upon Calderon and Shakspeare, is in the text marked by inverted commas, I have extracted from an unpublished letter from Ludwig Tieck to me.

[101] (p. 65.)—The following is the order in which these works appeared: Jean Jacques Rousseau, 1759 (Nouvelle Héloïse); Buffon, 1778 (Epoques de la Nature; the Histoire Naturelle already in 1749—1767); Bernardin de St. Pierre, Etudes de la Nature, 1784, Paul et Virginie, 1788, Chaumière Indienne, 1791; George Forster, Voyage to the South Sea, 1777, Smaller Works, 1794. More than half a century before the appearance of Nouvelle Héloïse, Madame de Sévigné had already manifested in her charming letters a taste for Nature, which, in the great age of Louis XIV. was so seldom expressed. Compare the splendid natural delineations in the letters of April 20th, May 31st, August 15th, September 16th, and November 6th, 1671; of October 23rd, and December 28th, 1689. (Aubenas, Hist. de Madame de Sévigné, 1842, p. 201 and 427). A little afterwards, (p. 66), I have mentioned the old German Poet, Paul Flemming, who, from 1633 to 1639 accompanied Adam Olearius upon his Moscovite and Persian travels; I have done this, because according to the important opinion expressed by my friend

Varnhagen von Ense (Biograph. Memoirs, vol. iv. p. 4, 75 and 129), "the character of Flemming's poetry has a healthy and fresh power," and his pictures of Nature are delicate and full of life.

[102] (p. 68.)—Letter of the Admiral from Jamaica, on the 7th of July, 1503; "El mundo es poco; digo que el mundo no es tan grande como dice el vulgo." (Navarrete, Coleccion de Viages Espan., vol. i. p 300).

[103] (p. 70.)—*Vide* Journal and Remarks, by Charles Darwin, 1832—1836, in the Narrative of the Voyages of the Adventure and Beagle, vol. iii. p. 479—490, where a particularly beautiful description of Tahiti is given.

[104] (p. 70.)—On the Worth of George Forster as a Man and a Writer, *vide* Gervinus, History of the Poetical National Literature among the Germans, Pt. v. p. 390—392.

[105] (p. 71.)—Freytag's Account of the Arabian Art of Poetry, 1830, p. 402.

[106] (p. 75.)—Herod. iv. 88.

[107] (p. 75.)—A part of the works of Polygnot and of Micon (the picture of the Battle of Marathon in the Poecile at Athens) was, according to the testimony of Himerius, seen at the end of the 4th century, (after the Christian Era); these works were, therefore, at that time about 850 years old (Letronne, Lettres sur la peinture historique murale, 1835, p. 202 and 453.)

[108] (p. 76.)—Philostratorum Imagines, ed. Jacobs and Welcker, 1825, p. 79 and 485. Both these learned editors defend from the older suspicions, the truth of the descriptions of the pictures in the ancient Neapolitan Pinacothek (Jacobs, p. xvii. and xlvi., Welcker, p. lv. and lxvi.) Otfried Müller supposes, that the pictures of the Islands by Philostratus, (ii. 17) that of the marshy country, (i. 9) of the Bosphorus and the Fishermen, (i, 12 and 13) bore great resemblance to the representations upon the Mosaic of Palestrina. Also Plato mentions in the introduction to Critias (p. 107) how Landscape Painting lays before us the hills, rivers, and woods.

[109] (p. 76.—Especially in Agatharcus, or, at least, according to his rules. Aristot. Poet. iv. 16; Vitruv. lib. v. cap. 7, lib. vii. in Præf. (Ed. Alois. Marinius, 1836, vol. i. p. 292; vol. ii. p. 56). Compare Letronne, op. cit. p. 271—280.

[110] (p. 76.)—Objects of Rhopography, *vide* Welcken ad Philost. Imag., p. 397.

[111] (p. 76.)—Vitruv. lib. vii. cap. 5, (vol. ii. p. 91).

[112] (p. 76.)—Hirt's History of the Pictorial Art among the Ancients, 1833, p. 332. Letronne, p. 262 and 468.

[113] (p. 76.)—Ludius qui primus (?) instituit amœnissimam parietum picturam, Plin. xxxv. 10. The 'topiaria opera' of Pliny and the 'varietates topiorum' of Vitruvius were little landscape decorations upon the walls. The passage of Kalidasa quoted in the text, is in the Sakuntala, act vi. (Böhtlingk's translation, 1842, p. 90.)

[114] (p. 77.)—Otfried Müller, Account of Ancient Art, 1830, p. 609. As in the text I have alluded to some of the paintings in Pompeii and Herculaneum as specimens of art, but little allied to the freedom of Nature, I must here make one or two exceptions, which may be considered as landscapes in the modern sense of the word. *Vide* Picture of Herculaneum, vol. ii. pl. 45, vol. iii. pl. 53, and as a back-ground to a charming historical composition, vol. iv. pl. 61, 62 and 63. I do not mention the remarkable representation in the Monumenti dell' Instituto di Corrispondenza Archeologica, vol. iii. pl. 9, the genuine antiquity of which has been doubted by an acute archæologist, Raoul-Rochette.

[115] (p. 78.)—With respect to the supposition of Du Theil (Voyage en Italie par l'Abbé Barthélemy, p. 284) that Pompeii still existed in splendour under Hadrian, and was not completely destroyed until the end of the fifth century, *vide* Adolph v. Hoff, History of the Changes of the Earth's surface, Pt. ii. 1824, p. 195—199.

[116] (p. 78.)—*Vide* Waagen, Works of Art and Artists in England and Paris, Pt. iii. 1839, p. 195—201, and especially p. 217—224, where the famous Psalter of the Parisian library is described from the tenth century, and shews how long the love for antiquity remained in Constantinople. To the friendly and learned communications of this deep philosopher, (Professor Waagen, the director of the picture gallery in my native town) I owe the interesting notices concerning the history of Art in the time of the Roman Emperors which I produced in my public discourses in the year 1828. That which I afterwards wrote concerning the gradual development of the art of Landscape Painting, I communicated in the winter of 1835 to the distinguished author of the Italian Inquiries, Herr von Rumohr, in Dresden, who is since dead. From him I obtained a great number of historical illustrations, which he freely allowed me to publish, had the form of my work permitted me to do so.

[117] (p. 79.)—Waagen, op. cit. Pt. i. 1837, p. 59; Pt. iii. 1839, p. 352—359.

[118] (p. 80.)—"In the Belvidere of the Vatican, Pinturicchio painted landscapes as independent ornamental works; they were rich and well composed. He followed Raphael, in whose pictures are many of the isolated points of a landscape which are not derived from Perugino. In the pictures of Pinturicchio and his friends, we find those remarkably pointed mountain tops, which they had been in earlier times inclined to imitate from the Tyrolese pyramidal hills, which had become so famous by means of Leopold von Buch, and which might have made an impression upon travelling artists in the continued intercourse that existed between Germany and Italy. I rather believe that these pointed hills in the earlier Italian landscapes must be considered either as very old and conventional copies of the representations of mountains in ancient reliefs, and in mosaic work, or that they are unskilfully foreshortened views of Soracte, and similarly shaped separate hills in the Campagna of Rome." (From a letter from Charles Frederick von Rumohr to me in October, 1832.) In order more closely to point out the conical and pointed hills of which we are now speaking, I must remind the reader of the fanciful landscape which forms the back ground in Leonardo da Vinci's generally admired picture of Mona Lisa (wife of Francesco del Giocondo). Among those of the school of the Netherlands who have especially cultivated Landscape Painting as a distinct branch of art, we must mention Patenier's imitators, Herry de Bles, called "Civetta," because of his picture of the animal, and afterwards the brothers Matthew and Paul Bril, who by their residence in Rome, excited a great inclination for this particular form of painting. In Germany, Albert Altdorfer, Dürer's pupil, practised Landscape Painting somewhat earlier, and with more success than Patenier.

[119] (p. 80.)—Painted for the Church San Giovanni e Paolo in Venice.

[120] (p. 81.)—Wilhelm von Humboldt, Entire Works, vol. iv. p. 37. Compare also, concerning the different stages of the life of Nature, and the dispositions excited by the view of landscapes, Carus in his talented Letters upon Landscape Painting, 1831, p. 45.

[121] (p. 81.)—The great century of Landscape Painting included. John Breughel 1569—1625; Rubens 1577—1640; Domenichino 1581—1641; Philippe de Champaigne 1602—1674; Nicholas Poussin 1594—1655; Gaspard Poussin (Dughet) 1613—1675; Claude Lorrain 1600—1682; Albert Cuyp 1606—1672; Jan Both 1610—1650; Salvator

Rosa 1615—1673; Everdingen 1621—1675; Nicholas Berghem 1624—1683; Swanewelt 1620—1690; Ruysdael 1635—1681; Minderhoot Hobbema; Jan Wynants; Adrian van de Velde 1639—1672; Charles Dujardin 1644—1687.

[122] (p. 81.)—Wonderfully fanciful representations of date-palms, which have a knob in the middle of the foliage, are seen in an old picture of Cima da Conegliano of the School of Bellino (Dresden Gallery, 1835, No. 40).

[123] (p. 82).—Loc. cit. No. 917.

[124] (p. 83.)—Francis Post, or Poost, was born at Haarlem in 1624. He died there in 1680. His brother also accompanied Prince Maurice of Nassau, as Architect. Of his pictures, one which represents the shores of the Amazon is to be seen in the Gallery of Paintings at Schleisheim; others are at Berlin, Hanover and Prague. The etchings (in Barlæus, the Journey of Prince Maurice of Nassau, and in the royal collection of prints at Berlin), show a considerable degree of taste for Nature's beauties in the delineations of the form of the coast, the nature of the soil, and the vegetation. They represent the Musaceæ, Cactus, Palms, Fig-trees, with their well-known wooden growths at the foot of the stem, the Rhyzophora and the tree-like Grasses. The picturesque Journey in Brazil ends (Plate lv.) singularly enough, with a German pine forest surrounding the Castle of Dillenburg. The remark made above in the text (p. 83), respecting the influence which the establishment of botanical gardens in Northern Italy, about the middle of the 16th century, may have exercised upon their acquaintance with the characteristic forms of tropical plants, induces me to speak in this note of the well-established fact, that Albertus Magnus, so worthy of renown for keeping alive the Philosophy of Aristotle, and also for his researches in Natural History, most probably possessed a hot-house for plants in the 13th century in the Convent of Dominicans at Cologne. This distinguished man, suspected of witchcraft on account of his speaking machine, on the 6th of January, 1249, entertained the Romish King William of Holland, as he was travelling through the place, in a wide room in the garden of the Convent, in which, by a pleasant degree of warmth, he had preserved fruit trees and blossoming shrubs throughout the winter. An exaggerated and marvellous account of this feast is found in the Chronica Joannis de Beka, in the middle of the 14th century. (Beka et Heda de Episcopis Ultrajectinis recogn. ab. Arn. Buchelio, 1643, p. 79; Jourdain, Recher-

ches critiques sur l'age des traductions d'Aristote, 1819, p. 331; Buhle, History of Philosophy, Pt. v. p. 296). Although the Ancients, as certain single specimens from the excavations of Pompeii teach us, used panes of glass in their buildings, yet nothing has hitherto been discovered which indicates the use of glass-houses and hot-houses in the ancient art of Gardening. The cultivation of the Caldaria in baths might have given rise to the taste for such plants, and to the establishment of hot-houses, but the shortness of the winter in Greece and Italy, made the want of artificial heat less perceptible in their horticulture. The Gardens of Adonis (κῆποι 'Αδώνιδος), so indicative of the meaning of the Feasts of Adonis, were, according to Böckh, "Plants in little pots, without doubt, intended to represent the garden in which Venus associated with Adonis, the symbol of the quickly withering bloom of youth, of luxuriant growth and decay. The Adoniæ were festivals of the women, in which Antiquity lamented decaying Nature. As we speak of hot-house plants in contradistinction to those which grow naturally, so the Ancients used the word Adonis Garden proverbially, meaning thereby the quickly sprouting vegetation, which does not arrive at the strength and endurance of maturity. Vegetables, not blossoming flowers, but lettuces, fennel, barley and wheat, were brought to their full growth by industrious attention; and this not in winter, but in the height of summer, and in the space of eight days." Creuzer (Symbols and Mythology, Pt. ii. 1841, p. 427, 430, 479 and 481), believes also, that to accelerate the growth of plants in the Adonis Gardens "powerful natural and artificial heat in chambers was used." The Garden of the Convent at Cologne reminds us at any rate of the Convent of St. Thomas in Greenland or Iceland, whose gardens were always free from snow, and warmed by natural hot springs, as the Brothers Zeni have narrated in their travels (1388—1404), which, however, have but problematical truth in respect of their geographical accuracy. (Compare Zurla, Viaggiatori Veneziani, vol. ii. p. 63—69, and Humboldt, Examen crit. de l'Hist. de la Géographie, vol. ii. p. 127).—In our botanical gardens, the establishment of hot-houses appears to be much more recent than is generally believed. Ripe pine-apples were first produced at the end of the 17th century. (Beckmann, History of Discoveries, vol. iv. p. 287); Linnæus supposes in the 'Musa Cliffortiana florens Hartecampi,' that the first time when Pisang was seen in blossom in Europe was in the garden of Prince Eugene in Vienna, in 1731.

[125] (p. 84.)—These views of the vegetation of the Tropics, which give

a character to the Physiognomy of Plants, form in the Royal Museum at Berlin (Division of miniatures, drawings, and engravings), a treasure of Art, which, for its peculiarity and picturesque variety, is not to be compared with any other collection. The Plates, edited by Baron Kittlitz, have the title, View of the vegetation upon the Coasts and Islands of the Pacific Ocean, taken 1827—1829, upon the Voyage of Discovery of the Russian Imperial Corvette Senjäwin (Siegen, 1844). The Drawings of Charles Bodmer, which are well engraved, and ornament the grand work of the Travels of Prince Maximilian, at Wied, into the centre of North America, show great natural truth.

[126] (p. 88.)—Humboldt, Views of Nature, 2nd edition, 1826, vol. i. p. 7, 16, 21, 36 and 42. Compare also two very learned accounts; Frederic von Martius Physiognomy of the Vegetable Kingdom in the Brazils, 1824, and M. von Olfers, General View of the Brazils in Feldner's Travels, 1828, Pt. i. p. 18—23.

[127] (p. 95.)—William v. Humboldt in his Correspondence with Schiller, 1830, p. 470.

[128] (p. 96.)—Diodor, ii. 13. He describes the distinguished Garden of Semiramis as only twelve stadia in extent. The pasture land about Bagistan is still called the Circuit or Circumference of the Garden. Tauk-i bostan (Droysen, History of Alexander the Great, 1833, p. 533).

[129] p. 96.—In the Schahnameh of Firdusi it says, "Zerdujt planted a tall Cypress tree, sprung from Paradise, before the gate of the Temple of Fire, (at Kishmere in Chorasan). He wrote upon this lofty Cypress: Gujtasp has embraced the good faith; the tall Cypress was a witness thereof; thus God extends his righteousness. When many years had passed away, the tree developed itself, and became so great that a hunter's line would not enclose it. When from its summit numerous branches sprung, he enclosed it in a palace of pure gold . . . ., and caused it to be published abroad in the world. Where, upon earth, is there a Cypress like that of Kishmere? Out of Paradise God sent it to me, and said, Bow thyself down from thence towards Paradise." (When the Caliph Motewekkil caused the Holy Cypress to be cut down, it was considered to have attained an age of 1450 years). Compare Vuller's Fragments concerning the Religion of Zoroaster, 1831, p. 71 and 114; Ritter's Geography, Pt. vi. 1, p. 242. The original native country of the Cypress (Arabic. Ararholz, Persian Serw Kohi) appears to be the Mountains of Busih,

west of Herat; *vide* Edrisi, Géograph. traduit par Jaubert, 1836, vol. i. p. 464.

[130] (p. 97.)—Achill. Tat. i. 25; Longus Past. iv. p. 108, Schäfer. "Gesenius (Thes. linguæ hebr. vol. ii. p. 1124) very rightly lays it down as his opinion, that the word Paradise belongs to the ancient Persian language; it is no longer used in Modern Persian. Firdusi (although his own name is thence derived) generally makes use of the word 'behischt;' for its ancient Persian origin, we have expressly the testimony of Pollux in Onomast. ix. 3, and Xenophon, Œcon. 4, 13 and 21; Anabasis, i. 2, 7 and i. 4, 10; Cyropæd. i. 4, 5. As a pleasure garden, or garden, the word has probably passed from the Persian into the Hebrew (pardês Cant. 4, 13; Nehem. 2, 8 and Eccl. 2, 5), in the Arabic (firdaus: plural, farâdîsu, compare Alcoran, 23, 11 and Luc. 23, 43), the Syrian and Armenian, (partês, *vide* Ciakciak, Dizionario Armenio, 1837, p. 1194 and Schröder, Thes. ling. Armen. 1711, præf. p. 56). The derivation of the Persian word from the Sanskrit (pradêsa or paradêsa, circumference, region or country) which Benfey (Lexicon of Greek roots, vol. i. 1839, p. 138), Bohlen and Gesenius have brought forward, corresponds perfectly in form, but too little in point of meaning."—Buschmann.

[131] (p. 97.)—Herod. vii. 31 (between Callatebus and Sardes.)

[132] (p. 97.)—Ritter's Geography, Pt. iv. 2, p. 237, 251 and 681; Lassen's Indian Antiquity, vol. i. p. 260.

[133] (p. 97.)—Pausanias, i. 21, 9. Compare also Arboretum sacrum in Meursii Opp. ex recensione Joann. Lami vol. x. (Florent. 1753) p. 777—844.

[134] (p. 98.)—Notice Historique sur les Jardins des Chinois, in the 'Mémoires concernant les Chinois,' vol. viii. p. 309.

[135] (p. 98.)—Op. cit. p. 318—320.

[136] (p. 99.)—Sir George Staunton's Account of the Embassy of the Earl of Macartney to China, vol. ii. p. 245.

[137] (p. 99.)—Fürst v. Pückler-Muskau, Remarks upon Picturesque Gardening, 1834. Compare with it his artistic descriptions of the old and new English Park and of the Egyptian Gardens of Schubra.

[138] (p. 100.)—Eloge de la Ville de Moukden, poëme composé par l'Empereur Kien-long, traduit par le P. Amiot, 1770, p. 18, 22—25, 37 63—68, 73—87, 104 and 120.

[139] (p. 100.)—Mémoires concernant les Chinois, vol. ii. p. 643—650.

[140] (p. 101.)—Ph. Fr. von Siebold, Kruidkundige Naamlijst van Ja-

pansche en Chineesche Planten, 1844, p. 4. What a difference we see, if we compare the great variety of plants that have been cultivated for so many centuries in East Asia, with these few which Columella describes in his dull poem (v. 95—105, 174—176, 255—271, 295—306) and to which the women who twined the garlands in Athens were restricted! The inclination to multiply the number and variety of their plants, by artificial culture during the winter, first appeared in Alexandria and Egypt under the Ptolemies. (Compare Athens, v. p. 196.)

CONTEMPLATIONS OF THE PHYSICAL WORLD IN THE EPOCHS OF HISTORY.

PRINCIPAL STEPS IN THE GRADUAL DEVELOPMENT OF EXTENSION OF THE IDEA OF KOSMOS AS AN UNITY.

THE History of a physical survey of the World is the history of the knowledge of an Unity in Nature, and an account of the attempts of mankind to understand the co-operation of the powers upon earth and in the heavens: it represents the different eras in the advance of general views, and is a part of the history of our world of ideas, as far as it concerns the objects of sense, and the forms and properties of matter.

In the first part of this work, in the section upon the limitation and scientific treatment of a Physical History of Creation, I believe that I have clearly shewn how the separate natural sciences relate to the description of the earth, that is, to the study of Kosmos (Unity of Nature), and how the study only draws out of them the materials for her scientific foundation (1). The history of the knowledge of the world, (as a whole,) and the ideas leading to it which I here lay down, and which, for the sake

of brevity, I call at one time "the History of Kosmos," at another, "the History of a physical Survey of the World," must not be confounded with a "History of the natural Sciences," as many of our best manuals upon physics, or the works upon the morphology of plants and animals, have been.

In order to give an account of the meaning of that which we can place within the scope of separate historical ages, it appears most convenient to specify, by means of examples, what the object of these pages excludes, and what must be treated of in them. To the History of Nature, as a whole, belong the discoveries of the compound microscope, the telescope, and the polarization of light: because they have afforded us means of finding out that which is common to all organized beings; to penetrate into the distant skies, to distinguish reflected from real light—that is, whether the light of the sun radiates from a solid body, or from a gaseous surrounding matter. But to narrate the attempts which, since the time of Huygen, have gradually led to Arago's discovery of polarization, belongs to the history of Optics. Thus, the history of "Photognomy," or Botany, and the development of the principles according to which the vast numbers of differently formed plants have been classified into families, is not part of our subject: whilst the Geography of Plants, or the insight into the local or climatic dispersion of the vegetable kingdom over the land, and the basin of the sea, so rich in *Algæ*, makes an important section in our History of the physical Survey of the World.

The deliberate consideration of that which has led

to this insight into Nature as a whole, is as little the entire history of the culture of man, as that we have just named can be called a History of the natural Sciences. Certainly, the insight into the connection of the living powers of the universe is to be looked upon as the noblest fruit of the cultivation of man, and as the endeavour to attain the highest pinnacle which the improvement and the perfection of the intellect can reach; but that which we here indicate, is only a part of the history of the civilization itself. This includes everything that represents the progress of all nations towards the attainment of an elevated mind and system of morality. We arrive at a limited physical point of view of the history of human knowledge only upon one side; we direct our attention especially to the circumstances concerning the gradual establishment of the idea of Kosmos; we dwell less upon the extension of separate doctrines, than the results which are capable of being generalized, or which have afforded powerful aid, in a closer observation of Nature in different ages of the world.

We must be especially careful that an early intimation of anything, and the real knowledge of it are clearly distinguished from each other. As the civilization of the human race progressed, much that belongs to the first of these passes into the second, and this confusion clouds the history of the discoveries. A sensible and ideal combination of what has already been established frequently leads, almost unconsciously, to the faculty of anticipating, and elevates it, as it were, by the power of inspiration. How much has been said by the Indians and Grecians, and in the Middle Ages, respecting the

connection of natural phenomena, being at first unproved, and mixed with what appeared without the slightest foundation, but when in after times new experience supported it, it became scientifically known! The imaginative foresight, and the wonderful activity which influenced Plato, Columbus, and Kepler, must not be considered as having been of no service in the province of science, nor as if from their very essence they must altogether be withdrawn from investigating realities.

Having thus defined the "History of the contemplation of the physical World," to be the "History of the knowledge of Nature as a whole," or the History of the idea of Unity in phenomena, and the mutual influence of the powers in the Universe, our mode of treating the subject can only consist in the narration of everything by which the idea of Unity in phenomena has been gradually developed. We distinguish, in this respect, first, the independent effort of the reason in the acquirement of natural laws, and, therefore, a thoughtful consideration of natural phenomena; secondly, the events of the world which have suddenly widened the extent of the horizon of observation; thirdly, the discovery of new means of sensible perception, such as the invention of new instruments, which bring man into nearer intercourse with earthy objects, as well as with the distant bodies in the universe, and which render our powers of observations more acute and manifold. This triple point of view must guide us, if we would determine the chief eras, through which the history of the study of Kosmos has to pass. In order to illustrate what we have brought forward, we will here cite some examples to characterize

the different means by which mankind has gradually attained intellectual possession of the greater part of the world; examples of extended acquaintance with Nature, of grand events, and of the discovery of new instruments.

The acquaintance with Nature, the most ancient physical knowledge of the Greeks, was rather deduced from their internal contemplations, and the depths of their minds, than from their perception of phenomena. The natural philosophy of the Ionian physiologists was directed to the primitive cause of existence, and the varied form of one simple elementary substance; on the other hand, the mathematical symbols of the Pythagoreans, and their considerations respecting number and form, indicated a philosophy of measure and harmony. Whilst the Doric Italian school especially looked for numerical elements, and acknowledged a certain taste for the relations of numbers in reference to time and space, it also laid the foundation for the later improvement of our experimental sciences. History of the survey of the world as I comprehend it, does not mean so much the repeated fluctuations between truth and error, as the principal epochs in the gradual approach to the truth, and to a correct view of the powers of the earth and of the system of planets. It shows to us, how the Pythagoreans, according to the account of Philolaus and Croton, taught the advancing movement of the earth without rotation, and its circular course round the axis (the central fire, Hestia); whilst Plato and Aristotle considered the earth neither progressing nor rotating, but immovably suspended in the centre. Hicetas of Syracuse,

who is at any rate more ancient than Theophrastus, Heraclides Ponticus and Ecphantus, were acquainted with the rotation of the earth round its axis; but only Aristarchus of Samos, and Seleucus of Babylon, a century and a half after Alexander, knew that the earth not only rotates, but that at the same time it moves round the sun, the centre of the system of the planets. The belief in the immobility of the earth returned in the dark period of the Middle Ages, from the fanaticism of some of the Christians, and the still existing influence of the Ptolemean system of astronomy, and according to the Alexandrian philosopher, Cosmas Indicopleustes, its form was considered to be that of a disc; but a German cardinal, Nicholas de Cuss, had the freedom of spirit, and the courage, nearly a hundred years before Copernicus, to ascribe to our planet again both its rotation and its progressive motion. After the system of Copernicus, Tycho's doctrine was a retrograde step, but one of very short duration. As soon as a greater number of new observations was collected, to which Tycho himself richly contributed, an accurate view of the formation of the earth could not be long deferred. We have here shewn how the *period of fluctuation*, especially consisted in anticipations and philosophical fancies.

After the perfection of our acquaintance with Nature, as a simultaneous consequence of actual observation, and a combination of ideas, I have above reckoned those great events, by which the extent of survey has been considerably enlarged. Among them we must include the wanderings of nations, voyages and the marches of armies.

They have collected information respecting the natural peculiarities of the earth's surface (the forms of continents, the direction of mountain ranges, and the relative heights of table lands), and have afforded materials for the establishment of general natural laws in distant regions. In our historical survey, we do not require a connected account of events. For the history of our acquaintance with Nature, it is sufficient to record in each age those occurrences which may have exercised any decided influence over the exertions of the human intellect, and the extension of man's views of the World. In this respect, for the nations settled around the basin of the Mediterranean, the Voyage of Colæus of Samos to the other side of the Pillars of Hercules, the march of Alexander into India, the vast Empire of the Romans, the spread of Arabian civilization, and the discovery of the New World, have been affairs of vast importance. It is not so much our province to narrate anything that has happened, as to point out the effect which the occurrence, (whether it is a voyage of discovery, or the general prevalence of some language rich in literature, and in a high state of perfection, or the sudden increase in our acquaintance with the Indo-African Monsoon), has exercised upon the development of the idea of Kosmos.

As in this heterogeneous collection of inducements, I have mentioned language as an example, I will here, in general terms, draw the attention of my readers to its immeasurable importance in two very different directions. Languages are of influence singly, by being widely diffused, as a means of communication between races of mankind separated one from another by a great

distance; and they are of influence upon the deeper study of man's history, when they are compared together, by the insight that is obtained into their actual organization, and their degree of relationship. The Grecian language, and the nationality of the Greeks (Grecian Life), so closely united with it, have had a magical effect upon all foreign nations with whom they had intercourse.(2) The Greek language appears in central Asia, from the influence of the Bactrian Kingdom, as a bearer of knowledge, which was brought back mixed with Indian notions a thousand years afterwards, by the Arabians into the west. The old Indian and Malay languages have advanced trade and commerce between the inhabitants of the islands in the south-east of Asia, in the eastern coast of Africa and of Madagascar, and very probably, from the account of the Indian trading stations of the Banians, were the cause of the bold undertaking of Vasco de Gama. Any languages which have become very extensively used, and thus unfortunately lead the way to the early loss of the idioms that are disused, have, like Christianity and Buddhism, acted beneficially in promoting the union of mankind.

Compared to one another, and considered as objects of the natural history of the mind, and separated into families, according to the analogy of their structure, languages have become a rich source of historical knowledge, and this is one of the grandest results of modern studies, namely, of the last sixty or seventy years. Since they are the production of the mental power of mankind, they lead us, by means of the principles of their formation, into a gloomy distance beyond the reach of any tradition. The study and comparison of languages show, how races

separated by vast regions are related to one another, and are derived from one original common country. They point out the route and direction of ancient wanderings; and by the investigation of the development, by the greater or less change of the forms, by the pre-eminence of certain idioms, and by the progressing distinction or dissolution of the system of forms, they determine what race has preserved most closely the languages which had been common to all of them, and which was used in their original country. The long chain of Indo-germanic languages from the Ganges to the most western part of Europe, and from Sicily to the North Cape, gave great occasion to this kind of inquiry with respect to the ancient condition of these languages, at a time when mankind might be regarded as a living natural Unity in the truest sense of the word. This history and comparison of languages also traces back to their native country, certain natural productions which have been articles of barter and commerce from the earliest times. The Sanscrit names of genuine Indian productions, as rice, cotton, spikenard and sugar, are found to have passed into the Greek, and also partly into the Semitic languages ([3]).

According to the considerations which we have here laid down, and illustrated by examples, the comparative history of languages appears to be an important national means of arriving (by scientific and genuine philological inquiries) at a general view of the relationship of the various tribes of man, and the probably numerous original points from which the propagating rays diverged. The rational means of arriving at the gradually developed study of Kosmos are of a different kind: examination into

the structure of the language, deciphering old inscriptions and historical monuments in hieroglyphics and the cuneiform letters, the perfection of mathematics, especially the all-powerful analytical calculus, which includes the knowledge of the form of the earth, the tides of the sea and the sky. Lastly, to all these means we must add the material discoveries which give us new organs, and heighten the powers of our senses, and bring man into nearer intercourse with the powers of earth, and the distant heavenly bodies. To mention those instruments which indicate great epochs in the history of civilization, I may name the telescope, and its too recent union with instruments of measurement; the compound microscope which enables us to follow the various stages in the development of organic beings ("of the formative power, the origin of existence," as Aristotle says); the compass, and the different arrangements for exploring the phenomena of the earth's magnetism; the use of the pendulum to measure time, the barometer, thermometer, hygrometrical and electrical apparatus; the polariscope in the examination of the phenomena of colours in the light of the stars, or in the atmosphere.

The History of the physical Survey of the World, founded as we have just shown, upon the careful examination of natural phenomena, upon the links of the great events of the world, and upon discoveries which enlarge the circle of sensible perceptions, must here be laid down in its principal points, superficially and disjointedly. I flatter myself with the hope that the shortness of my representation will be able to put the reader in a position to understand easily the spirit in which a picture limited

with no great difficulty is to be carried out. Here as in the picture of Nature, which the first volume of Kosmos contains, we do not endeavour so much to give a complete account of particular things, as to devélope clearly, leading ideas, and to point out some of the roads to be taken, both in the physical investigation of Nature and by the historian. The knowledge of the connection of events and the relation of their causes being laid down beforehand as a datum, the occurrences themselves need not be narrated, it is sufficient to name them, and to determine the influence which they exercised upon the gradually increasing knowledge of nature. A complete account, I think I must repeat, is here neither to be attained nor to be looked upon as the object of such an undertaking. When I say this, in order to preserve for my work upon Kosmos its peculiar character which alone makes it practicable, I shall certainly again expose myself to the censure of those who dwell less upon what a book contains, than upon that which is found in it to correspond with their own particular views. In very ancient parts of history, I have been intentionally much more circumstantial than in more modern times; for in them the streams flow more sparingly, the combination is more difficult, and the opinions which I bring forward require the assistance of testimony not generally known. I have also freely allowed myself to treat of the subjects unequally, wherever it happens that by a particular description I can give a more lively interest to my treatise.

As our knowledge of the universe began with intuitive perceptions, and with but few real observations upon separate phenomena of Nature, so in our historical view

of the survey of the earth, we must start from a very limited space. We choose the sea, surrounded by those races, upon whose knowledge our western civilization (the only one which has advanced uninterruptedly) is chiefly founded. We can point out the principal streams which have brought the elements of civilization, and of an extended view of Nature into the west of Europe, but in the multiplicity of those streams we cannot point out an original single fountain head. Deep insight into the powers of Nature, and knowledge of Nature as a whole are not found in a so called original people, which according to different historical opinions, was at one time considered to be a Semitic race in the northern Chaldæan Arphaxad (4) (Arrapachitis of Ptolemæus), at another the race of the Indians and Iranians in the ancient Zendland (5) at the source of the Oxus and Jaxartes. History, as far as it is founded upon human testimony, knows no original people, no first seat of civilization, no original natural philosophy, or natural wisdom, where the splendour has been clouded by the sinful barbarity of later centuries. The historian breaks through the numerous interposing mists of symbolical fables, in order to arrive at secure ground, upon which the first germ of man's civilization has developed itself by natural laws. In grey antiquity, and at the farthest horizon of authentic history, we see, simultaneously, numerous light points, the centres of civilization, radiating towards each other; as, Egypt at least five thousand years before our era (6); Babylon, Nineveh, Cashmere, Iran and China, since the first colony which wandered from the north-east declivity of the Kuen-lün mountains, into the lower valley of the

Hoangho. These central points remind us involuntarily of the greater lights among the stars of the firmament, and of the eternal suns of the universe, whose brightness we know, but with few exceptions (7), are not acquainted with their relative distances from our planets.

The natural philosophy possessed by the first races of mankind, and the natural wisdom of wild races which became obscured by civilization, belong to a sphere of knowledge, or rather of belief, which is foreign to the subject of this work. We nevertheless find such belief deeply rooted in the most ancient Indian doctrine of Krishna (8), "Truth is said to have been originally implanted in man, but it gradually fell asleep and was forgotten; knowledge returns like a recollection." We willingly leave it undetermined, whether the races which we now call wild, are all in a condition of original natural rudeness; or whether many of them, as the structure of their language leads us to suppose, have not grown wild, like the scattered fragments from the shipwreck of some early departed civilization. A closer intercourse with these so called natural men, teaches us nothing of all that the love of the marvellous has fabulously reported, respecting a certain pre-eminence in knowledge of the phenomena of the earth, said to be possessed by savage nations. A hollow and dreadful feeling of the Unity of the powers of Nature appears in the minds of savages, but such a feeling has nothing in common with the attempt to include the connection of phenomena under the form of ideas. A true view of Kosmos is the result of observation and ideal combinations, and of the long continued contact of mankind with the external world; it is not the work of a

single nation, but the fruit of mutual communications of a great, if not a general intercourse.

As in our remark concerning the reflection of the external world upon the imaginative powers, in the beginning of this volume, we extracted from the general history of literature whatever indicated a lively feeling for Nature, so in our history of the examination of the world, we shall take from the general history of civilization all that shows any progress in the knowledge of Nature as a whole. Both parts (separated from one another, not arbitrarily, but according to certain fixed principles), have the same relations to each other, as the doctrines from which they are borrowed. The history of the civilization of man includes the history of the original powers of his mind, as well as an account of the works in which these powers have shewn themselves, in the different spheres of literature and art. In like manner we recognize, in the depth and liveliness of a taste for Nature's beauties, which we have delineated according to the differences of the times and races of mankind, real inducements to notice the phenomena more carefully, and earnestly to explore their connection with our history of the Earth.

Since the streams which have carried along the elements of an extended acquaintance with Nature, and in the course of time have diffused them unequally over the surface of the earth, are so manifold, it is, as we have above remarked, most suitable to our history of the World, to start from one race of mankind, and from that one especially, in which our present civilization and knowledge, and that of the whole of the west of Europe, originated. The mental culture of the Greeks and Romans is indeed,

even from their very beginning, modern in comparison with that of the Egyptians, Chinese, and Indians; but that which flowed to them from without, namely from the east and south, has uninterruptedly propagated itself upon European ground, together with their own productions and discoveries, in spite of the continual change of the events of the world, and the vast intermixture of foreign nations. In the regions where thousands of years ago there was much science, we find either that obscure barbarism has again appeared, or that with the maintenance of their old habits, and of a solid and complex political constitution (as in China), the advance in science and in the industrious arts is small, and their share in the commerce of the world, without which general views cannot be formed, is still less. Civilized Europeans and their descendants who have migrated to other continents, from the vast extension of navigation into the most distant seas and upon the farthest shores, appear to have become almost ubiquitous. That which they do not possess, they can command. In their almost uninterrupted hereditary knowledge, and in their long existing scientific nomenclature, they possess, as landmarks in the history of man, records of the many courses by which important discoveries, or at least their germs have streamed down to the inhabitants of Europe; from the east of Asia we derived our acquaintance with the direction and variation of the magnetic needle; from Phœnicia and Egypt, chemical manufactures (glass, animal and vegetable dyes, and the oxides of metals); from India the general use of *Position*, in calculating the increased amount of a few numerical signs

Since civilization has left her most ancient settlement within the tropics, or in the zones near the tropics, she has rested in those parts of the world, whose most northern regions are less cold than in Asia and America, although within the same latitudes. The continent of Europe is a western peninsula of Asia, and I have shewn in an earlier part of this work, how it owes the greater mildness of its climate (so favourable to general civilization), to this circumstance, as well as to its varied and intersected form, already extolled by Plato, to its position opposite tropical Africa, and to the prevailing westerly winds which blow warmly in the winter months across the Atlantic ocean (9).

The physical condition of Europe has opposed fewer obstructions to the spread of civilization than that of Asia and Africa, where the extensive parallel mountain ranges, table lands and sandy deserts interposed almost impassable barriers between the different races. In our account of a contemplation of the physical world in the epochs of history, we shall begin with a portion of the globe, which, by its relative situation in the earth, has had the greatest effect in forwarding the changing intercourse of nations, and the extension of general ideas of Kosmos, the ordinary result of such communication.

PRINCIPAL STEPS IN THE HISTORY OF A PHYSICAL STUDY OF THE EARTH.

I.—THE MEDITERRANEAN AS A STARTING POINT IN REPRESENTING THE RELATIONS WHICH HAVE CAUSED THE GRADUAL EXTENSION OF THE IDEA OF KOSMOS —THE ORDER OF THESE REPRESENTATIONS IN THE EARLIEST CULTURE OF THE GREEKS — ATTEMPTS AT DISTANT VOYAGES TOWARDS THE NORTH-EAST (THE ARGONAUTS), TOWARDS THE SOUTH (OPHIR), AND TOWARDS THE WEST (COLÆUS OF SAMOS).

Plato, in his Phædon, delineates the narrowness of the Mediterranean altogether in the sense of an enlarged view of the world (10). "We," says he, "who dwell between Phasis and the Pillars of Hercules, have here only a small portion of the earth, in which we have settled ourselves round the (internal) sea, like ants or frogs round a marsh." And this narrow basin, upon whose borders the Egyptian, Phœnician and Grecian nations have attained to a high degree of civilization, was the central commencing point of the most important events of the world, the colonization of the vast countries of Asia and Africa, and of

the naval undertakings by which an entire western hemisphere has been discovered.

The Mediterranean still preserves in its present form the traces of its former subdivision into three separate smaller seas, bordering upon one another (11). The Ægean Sea is bounded upon the south by an arched line, which passes from the Carian coast of Asia Minor through the Island of Rhodes, Crete and Cerigo, and terminates at the Peloponesus, not far from the promontory of Malea. The Ionian Sea is to the west, the basin of Syrtes, in which Malta lies. The western point of Sicily is at that point about twelve geographical miles from the coast of Africa. The sudden appearance (although it was but of short duration) of the volcanic island Ferdinandea, which was raised up in 1831, south-west of the limestone rocks of Sciacca, indicates an attempt of Nature (12) to close again the basin of the Syrtes between Cape Grantola, the Adventure Bank which was explored by Captain Smyth, Pantellaria, and the African Cape Bon, and thus to separate it from the western or third sea, the Tyrrhenian basin. The latter receives through the pillars of Hercules, the ocean rushing in from the west, and includes Sardinia, the Balearic isles, and the little volcanic group of the Spanish Columbrates.

The form of the Mediterranean, thus triply constricted, had a great influence on the early limitation and later extension of the Phœnician and Grecian voyages of discovery. In the time of Homer, the main-land of Italy was still "an unknown country." The Phoceans discovered the Tyrrhenian Sea, west of Sicily, and the navigators from Tartessus sailed to the Pillars of Hercules. We must

not forget that Carthage was founded upon the boundary of the basin of the Tyrrhenian Sea and that of the Syrtes. The physical form of the coasts affected the course of events, the direction of naval expeditions and the change in the empire of the sea; the latter in turn influenced the extent of the circle of man's ideas.

The northern shore of the inner or Mediterranean Sea has the advantage (already noticed by Eratosthenes after Strabo) of having a richer form ("more varied in shape") and more intersected than the southern Libyan coast. There, three peninsulas (13), the Spanish, Italian and Grecian, extend forwards into the sea; they are divided by variously-formed bays, and, with the islands in the neighbourhood and the opposite coasts, form narrow straits, both of sea and land. The shape of these continents, and of the islands which have appeared (being in part torn asunder from the main land, or in part raised up in lines by volcanic force, as it were upon continuous clefts in the earth) drew attention at an early age to scientific geographical views respecting breaches and convulsions on the surface of the earth, and the outpouring of the higher swollen seas into those which lie below. The Euxine, the Dardanelles, the Straits of Cadiz, and the Mediterranean itself, so abounding in islands, were well adapted to call forth the idea of such a system of flood-gates. The Argonaut Orpheus, probably in Christian times, has interwoven old traditions in his songs; he sings of the shattering of the ancient Lyctonia, into several islands when "the licentious Posidon, angry with his father Saturn, struck upon Lyctonia with his golden trident." Similar fancies, which may indeed frequently

have arisen from an incomplete acquaintance with the relative situations of countries, were spun out in the school of Alexandria, so rich in learning and so much addicted to the study of antiquity. Whether the fables of the shattering of Atlas were only a more distant and westerly repetition of those of Lyctonia, the probability of which I think I have elsewhere shewn, or whether according to Otfried Müller "the destruction of Lyctonia (Leuconia) points at the Samothracian tradition of a great flood overturning that region (14)" need not be decided here.

But that which, as I have already frequently remarked, has made the geographical situation of the Mediterranean so particularly felt in its influence upon the intercourse of nations, and the continual spread of their knowledge, is its propinquity to the eastern continent, through the peninsula of Asia Minor, the number of islands in the Ægean Sea, which have formed a bridge (15) for the transmission of civilization, and the depression between Arabia, Egypt and Abyssinia through which the great Indian Ocean streams, under the name of the Gulf of Arabia or the Red Sea, and separates by a narrow slip of land these countries from the Delta of the Nile and the south-east coast of the Mediterranean. By means of these local relations, the influence of the sea as the element which united nations together, was recognised in the increasing power of the Phœnicians, and afterwards in that of the Grecians, and in the quick development of the range of ideas among these races. Civilization in its earliest settlements had been limited in Egypt, upon the Euphrates and Tigris, in the Indian Pentopotamia and in

China, to regions richly abounding in rivers; not so in Phœnicia and Greece. In the active life of the Grecians, especially among the Ionians, their early inclination to nautical enterprise found ample cause for contentment in the remarkable form of the basin of the Mediterranean, and in its relative position with regard to the ocean to the south and west.

The existence of the Arabian Gulf from the irruption of the Indian Ocean through the Straits of Babel-mandeb, belongs to the class of great physical phenomena which our more recent mode of studying the earth has alone been able to explain. The continent of Europe is directed in its longest axis from the north-east to the south-west; but almost at right angles with this direction, we find a set of fissures which have partly permitted the incursion of the waters of the sea, and partly caused the elevation of parallel mountain ranges. This reversed direction from south-east towards the north-west (from the Indian ocean to the course of the Elbe in the north of Germany) is seen in the Red Sea in the southern part of the fissure, surrounded upon both sides by volcanic mountains, the Persian Gulf, with the low country between the parallel streams of Euphrates and Tigris, the mountains of Zagrus in Kurdistan, the chains of Greece and the neighbouring rows of islands in the Archipelago, the Adriatic and the Dalmatian Alps. The crossing (16) of these two systems of lines (from north-east to south-west and from south-east to north-west) which doubtless owes its origin to the direction of the convulsions in the centre of the earth, and of which I consider that running from south-east to the north-west to be the most recent,

had the most important influence upon the fate of man and the increase in the facility of national intercourse. The relative position and the inequality of temperature in Eastern Africa, Arabia and the Peninsula of India, dependent upon the declination of the sun in different seasons, produce a recurring and regular change in the winds (Monsoon) (17), which favour the voyages to the "Regio Myrrhifera" of the Adramites in Southern Arabia to the Persian Gulf, India and Ceylon; thus, in the season (April and May to October) when the north winds prevail in the Red Sea, the south-west monsoon blows from East Africa to the coast of Malabar, whilst the north-east monsoon (October to April) which favours the return of the ships, coincides with the period when the south wind blows from between the Straits of Babel-mandeb to the Isthmus of Suez.

Having thus sketched the history of the physical survey of the world, and represented the sources from which strange elements of civilization and of natural knowledge might be brought to the Greeks on every side, we will here point out, in the first place, those among the nations upon the Mediterranean Sea who had the advantage of an ancient and distinguished culture: they are, the Egyptians, the Phœnicians with their northern and western African colonies, and the Etruscans. Emigration and commerce here exerted the greatest influence. The more our historical knowledge has been increased by the most recent discoveries of monuments and inscriptions, and by more philosophical inquiries into ancient languages, so much the more manifold does the influence appear, which was exercised upon the Greeks in the earliest times, from the

Euphrates, through the medium of the Lycians and the Phrygians, who are related to the Thracian race.

In the valley of the Nile, which has played so conspicuous a part in the history of mankind, "a succession of kings is clearly traced" (I follow the newest investigations of Lepsius ([18]), and the results of his expedition, so important in the study of the whole of antiquity) "as far as the beginning of the fourth dynasty of Manethon, which includes the founders of the great Pyramids of Giseh (Chephren or Schafra, Cheops-Chufu and Menkera or Mencheres). This dynasty began more than thirty-four centuries before our Christian era, twenty-three centuries before the Dorian migration of the Heraclidæ into the Peloponesus ([19]). The great stone Pyramid of Dahshur, a little south of Giseh and Sakkara is considered by Lepsius as the work of the third dynasty. Upon the blocks composing them are found inscriptions of the masons, but hitherto the names of no kings have been discovered. The last dynasty of the old kingdom, which ended with the ruin of the Hyksos, about twelve hundred years before Homer, was the twelfth dynasty of Manethon, to which Amenemha the Third belonged; he was the founder of the original labyrinth, and made the artificial lake Mæris by excavations and extensive dams towards the north and west. After the expulsion of the Hyksos, the new kingdom began with the eighteenth dynasty (sixteen hundred years before Christ). The great Ramses-Miamun (Ramses II) was the second ruler in the nineteenth dynasty. His victories, immortalized by figures in stone, were interpreted to Germanicus by the priests in Thebes ([20]). Herodotus mentions him under the name Sesostris, having probably confounded

him with the equally warlike and powerful conqueror Seti (Setos) who was the father of Ramses the Second."

We have thought it necessary to dwell for a while upon the particulars of these eras, in order to be able to determine by approximation, the relative ages of the great events in Egypt, Phœnicia and Greece as far as possible upon accurate data. As we before delineated with but few touches the local relations of the Mediterranean, so we must now record the eras in the thousands of years in which human civilization in the valley of the Nile preceded that in Greece. Without considering it simultaneously with regard to time and space, we cannot, according to the real nature of the world of thoughts, lay down any clear or satisfactory historical view.

The civilization of the region of the Nile, having been early induced by the intellectual wants of the people, by a peculiar physical property of the country, and by political and sacerdotal influences, and being moulded in a constricted form, was, as is the case everywhere, the cause of intercourse with other nations, and of foreign invasions and colonies. That which history and monuments have made known to us, bears witness to conquests by land, but to few extensive sea voyages. This people, so ancient and so powerful, appears to have had less lasting influence upon other nations, than many more energetic and smaller races have had. The long work of national civilization, of more advantage to the mass than to individuals, was secluded by the local relations of the country, and therefore probably was but little influential in the prospects of the human race. Ramses-Miamun (from 1388 to 1322 before Christ, and therefore full six hundred years

before the first Olympiad of Corœbus) undertook distant marches, according to Herodotus, "into Ethiopia (where the most southern building that he erected was found by Lepsius on Mount Barkal) through Palestine and Syria, passing over from Asia Minor into Europe, to the Scythians, Thracians, and, lastly, to Colchis and the River Phasis, where some of his army, tired of wandering about, remained as colonists of the country. Thus Ramses at first, said the priests, with his long ships subdued the inhabitants of the coasts along the Erythrean Sea, until at last he came into a sea which, from its shallowness, was no longer navigable (21)." Diodorus says expressly that Sesostris (Ramses the Great) went into India beyond the Ganges and brought back prisoners out of Babylon. "The only authentic fact concerning the ancient sea voyages of the Egyptians themselves is, that from the earliest times they navigated, not only the Nile, but the Gulf of Arabia also. The renowned copper mines of Wadi Magara upon the peninsula of Sinai were worked even in the time of the fourth dynasty under Cheops-Chufu. The inscriptions of Hamamat in the Kossêr route, which joins the valley of the Nile with the western coast of the Red Sea, ascend as far back as the sixth dynasty. The digging of the canal of Suez was attempted (22) under Ramses the Great, chiefly on account of the commerce with the Arabian "copper country." Great nautical undertakings, such as even a voyage round Africa in the time of Neku the Second (from six hundred and eleven to five hundred and ninety-five years before Christ), which has been so often denied, but which seems to me to be by no means improbable (23), have been attributed to Phœnician sailors. About the same time, though a little

earlier, under Neku's father Psammetichus (Psemetek), and a little later, after the end of the civil war under Amasis (Aahmes), Greek mercenary troops settled in Naucratis and gave rise to a continued export trade, to the reception of foreign elements, and to the gradual introduction of Grecian customs into Lower Egypt. This was a germ of intellectual freedom and of greater independence from local influences, a germ which developed itself quickly and powerfully at the time of a new revolution of the world by the Macedonian conquests. The opening of the Egyptian ports under Psammetichus represents an epoch so much the more important, as until that time the country, at any rate upon its northern coasts, had, like Japan at the present time, been completely shut up from all strangers ([24]).

In our account of the civilized nations (except the Greeks) who lived around the basin of the Mediterranean, (the most ancient seat and point of origin of our knowledge) we include the Egyptians and Phœnicians. These must be considered as the active promoters of the intercourse of nations from the Indian Sea, to the west and north of the old Continent. There was one nation, however, which though limited in many particulars of intellectual growth, less acquainted with the fine arts than with the mechanics, and wanting in the grand imagination and acute sense of the inhabitants of the valley of the Nile, has earlier than all the other races of the Mediterranean, increased our circle of ideas, and enriched and multiplied our views of the world; these were the Phœnicians, a bold and active trading people, especially in establishing colonies, one of which, in political power, far surpassed the

mother city. They had the weights and measures of Babylon [25] and, at any rate after the time of the Persian Empire, stamped metal coins as a medium of exchange, which, wonderful to say, did not exist in the scientific and civilized state of the Egyptians. But the means whereby the Phœnicians principally aided in the civilization of the people with whom they came in contact, were the general spread and communication of the alphabet, and writing with letters, of which they themselves had long made use. Even though the whole story of a pretended colony of Cadmus in Bœotia remains enveloped in fabulous obscurity, it is nevertheless no less certain that the Greeks obtained the art of writing with letters, which they called for a long time "the Phœnician characters," from the commercial intercourse of the Ionians with the Phœnicians [26]. According to the views concerning the earlier conditions of the development of alphabetical writing, which, since Champollion's great discovery, have been more widely extending themselves, the Phœnician as well as the entire Semitic writing, is to be considered as a "vocal alphabet" originating from the hieroglyphic writing; that is, as one in which the ideal signification of the hieroglyphics is entirely neglected, and they are only looked upon as phonetic, or vocal letters.

Such a set of letters, in nature and original form a "syllabic alphabet," was well adapted to satisfy all the wants of description in the words of a language. "As the Semitic writing," says Lepsius, in his treatise upon the alphabets, "passed into Europe among the Indo-germanic nations, who commonly shew a much greater inclination to separate more distinctly the vowels and

consonants, and in this way must have led to the greater significance of the vowels in their languages, we connect important and influential changes with this syllabic alphabet (27). The efforts of those who advocated the cause of syllabic writing were completely successful among the Greeks. Thus the transference of the Phœnician letters into all the countries upon the shores of the Mediterranean, even into the north-west coast of Africa, did not only much facilitate the actual commercial intercourse between the nations, and form a common bond of union for numerous civilized races; but the art of writing with letters, which had become so general from its flexibility, was intended to fulfil a higher office. It was the bearer of the most noble treasure both in the spheres of intellect and feeling, of the investigating faculty of the senses, and the creative power of the imagination which the Greeks ever attained, and which they left behind as an imperishable inheritance to future generations.

The Phœnicians, however, have not only been an active and instrumental cause in increasing our ideas of the world; they have also themselves, by their discoveries and individual activity, extended our sphere of knowledge. A condition of industrious prosperity, founded upon an extended navigation, and upon the active manufacture at Sidon of white and coloured glass wares, and of materials for clothing and purple dying, here as everywhere else, led the way to progress in mathematical and chemical sciences, and especially in the technical arts. "The Sidonians," says Strabo, "were represented as being acute inquirers, both into the science of astronomy and the study of numbers, by means of which they excelled in the art of

calculating, and in sailing by night; for both these arts are inseparable from trade and commercial navigation (28)." In order to form an idea of the extent of the earth which was first discovered by the voyages and trading caravans of the Phœnicians, we name first the colonies in the Black Sea on the Bithynian coast (Pronectus and Bithynium) probably in very early times; the visit to the Cyclades, and many other islands of the Ægean Sea, about the time of Homer; the southern coast of Spain, abounding in silver (Tartessus and Gades); the north of Africa, west of the Syrtis Minor (Utica, Hadrumetum and Carthage); the tin (29) and amber islands of the north of Europe, and two manufactories (30) in the Persian Gulf, (Tylos and Aradus, the Bahrein islands).

The trade in amber, which was probably at first directed towards the western Cimbrian coasts (31), and then towards the Baltic, to the land of the Esthians, owes its origin to the boldness and perseverance of the Phœnician coasters. In our history of the contemplation of the world, this trade affords us, in its subsequent extension, a remarkable example of the influence which the desire for a single distant production can exert upon the establishment of commerce with inland nations, and an acquaintance with vast regions of the earth. Thus as the Phocean inhabitants of Marseilles brought the tin of Britain directly through Gaul to the Rhone, so the amber passed through Germany and the region of the Celts from one people to another, to the two valleys of the river Po in the Alps, and through Pannonia to the Borysthenes. Thus this land traffic at first united the coasts of the Northern Ocean with the Adriatic and the Black Seas.

From Carthage, and probably from Tartessus and Gades, which were colonies founded 200 years before, the Phœnicians explored a great part of the north-western coast of Africa, far the other side of Cape Bojador, even supposing that the river Chretes of Hanno is neither the Chremetes mentioned in the *Meteorology* of Aristotle, nor our Gambia (32). Many Tyrian towns were situated there; Strabo made their number amount to three hundred; they were destroyed by the Pharusii and the Negroes (33). Among them was Cerne (Dicuil's Gaulea according to Letronne), the principal station for their ships, and the chief trading of the colonized coasts. The Canary Islands and the Azores (the latter of which were taken by Don Fernando, Columbus' son, for the Cassiterides discovered by the Carthaginians), were towards the west, the Orkneys, Faroer Islands and Iceland towards the north, intermediate stations in the passage across to the New Continent. They point out the two ways in which the European part of the human race first became acquainted with the natives of the northern and middle parts of America. This consideration gives a very great importance (one, I may almost say, which affects the entire history of the world) to the question, whether and how early the Phœnicians from the mother country, or from their colonies, planted in Spain and Africa (Gadira, Carthage and Cerne) were acquainted with Porto Santo, Madeira and the Canaries. In a long chain of events we willingly inquire after the first link. It is most probable that full two thousand years elapsed from the founding of Tartessus and Utica by the Phœnicians, to the discovery of America by the northern route, that is to Erich Rauda's passage

to Greenland, which was shortly followed by voyages to North Carolina: before the discovery of the south-western route which Christopher Columbus took (for he started from near to Gadira of the ancient Phœnicians) two thousand five hundred years elapsed.

Now as the form of this work renders it incumbent upon us to generalize all our ideas, and we look upon the discovery of a group of islands, only forty-two miles distant from the African coast, as the first link in a long chain of similar attempts; so we must keep in mind, that we are not here speaking of a fanciful idea, raised up in the imagination, of Elysium the Islands of the Blessed, which were situated in the extreme limits of the ocean, and were warmed by the vicinity of the setting sun. It was supposed that in the farthest distance all the charms of life and the most precious productions (34) of the earth existed. The ideal country, the geographical fable of Elysium, was moved farther westward, beyond the Pillars of Hercules, as soon as the acquaintance of the Greeks with the Mediterranean became more extended. The real knowledge of geography, and the earliest discoveries of the Phœnicians, concerning the dates of which no certain notice has been transmitted to us, probably did not give origin to those fables of the Blessed Islands, but the fables have been interpreted in this way since. The geographical discovery has only given substance to the picture of the fancy, and furnished, as it were, a support for it.

Where more recent authors (as for example, the unknown compiler of a work attributed to Aristotle "A collection of wonderful Narratives," of which Timæus, and,

more particularly, Diodorus of Sicily made use) mention the beautiful islands which have been taken for the Canaries, they imagine that great tempests have led accidentally to the discovery. It is supposed that Phœnician and Carthaginian ships "which were sailing to the (already established) settlements on the coast of Libya" were driven out into the ocean. The occurrence is said to have taken place in the earliest times of the Tyrrhenian dominion of the sea, during the contest between the Tyrrhenian Pelasgi and the Phœnicians. Statius Sebosus and the Numidian King Juba, first gave names to the individual islands, but not in the Punic language, although they certainly followed notices contained in Punic books. Because Sertorius, when he was driven out of Spain, after the loss of his fleet, made his escape "to a group of only two Atlantic islands, ten thousand stadia west of the mouth of the Bætis," it has been supposed that Plutarch meant the two islands Porto Santo and Madeira ([35]), which Pliny clearly signified when speaking of the Purpurariæ. The powerful current in the sea, which upon the outside of the Pillars of Hercules is directed from north-west to south-east, might for a long time have prevented the coasters from discovering the islands most distant from the continent, only one of which (Porto Santo) was found to be inhabited in the fifteenth century. The summit of the great volcano of Teneriffe could not be seen from the Phœnician ships running along the coast of the mainland, on account of the curved form of the earth, even with very powerful refraction of the rays; but according to my investigations, it might be seen from the moderate heights round Cape Bojador ([36]), especially when there

was an eruption, and the light was reflected from a cloud floating above the volcano. It is supposed at the present day that eruptions of Mount Etna have been seen in Greece from the summit of Mount Taygetus (37).

In assembling the elements of a more extensive acquaintance with the earth, which streamed towards the Greeks from other parts of the basin of the Mediterranean, we have hitherto followed the Phœnicians and Carthaginians in their intercourse with the northern tin and amber countries, and in their settlements upon the western coasts of Africa near the tropics. It remains for us to record the southern voyages which led the Phœnicians a thousand miles east of Cerne and Hanno's "Western Horn," far beyond the equator into the Prasodian and Indian Seas. Now, although some doubt still exists, as to the exact locality indicated by the name of "Golden Countries," (Ophir and Suppara), and although they might mean either the western coast of the peninsula of India, or the eastern coast of Africa; yet it is certain that the Semitic race of mankind, which was so active and enterprising, and so early acquainted with letters, had access to the productions of the most varied climates, from the Cassiterides to south of the Straits of Babel-mandeb, far within the regions of the tropics. The flag of the Tyrians waved at the same time in Britain, and in the Indian Ocean. The Phœnicians had settlements in the northern parts of the Arabian Gulf, at the sea-ports of Elath and Ezion-Gaber, and in the Persian Gulf at Aradus and Tylos, where, according to Strabo, there was a temple, in style of architecture like those of the Mediterranean (38). The trade by means of caravans,

carried on by the Phœnicians in spices and frankincense, was directed through Palmyra to Arabia Felix, to the Chaldæan and Nabatæan Gerrha upon the western or Arabian shore of the Persian Gulf.

Expeditions, the joint undertakings of the Tyrians and Israelites, were sent by Hiram and Solomon from Ezion-Gaber, through the Straits of Babel-mandeb to Ophir (Opheir, Sophir, Sophara, the Sanscrit Suppara of Ptolemæus) (39). Solomon, who loved splendour, had a fleet built upon the Red Sea, Hiram gave him Phœnician seamen, skilled in navigation, and also Tyrian ships (sailors of Tarshish) (40). The wares which were brought from Ophir were gold, silver, sandal wood (algummim), precious stones, ivory, monkeys (kophim), and peacocks (thukkiim). The names for these articles of commerce are not Hebrew, but Indian (41). According to the acute investigations of Gesenius, Benfey and Lassen, it is very probable that the Phœnicians, who early became acquainted with the periodical occurrence of the monsoon, from their colonies in the Persian Gulf, and their intercourse with the Gerrhæans, visited the western coasts of the peninsula of India. Christopher Columbus was completely convinced that Ophir (Solomon's Eldorado), and the mountain of Sopora is a part of East Asia, of the "Chersonesus aurea" of Ptolemæus (42). It seems difficult to look upon India as a productive country for gold, but at the same time I believe that allusion was not made to the "gold-seeking ants," or Ctesias' evident description of a "foundry," in which according to his account, gold and iron were melted at the same time (43), but only to the geographical propinquity of the south of

Arabia, and the Island of Dioscorides, inhabited by Indian settlers (Diu zokotora of modern times, a corruption of the Sanscrit word Dvipa Sukhatara), and to the east African coast of Sofala, where gold is found. Arabia, and the island which I have just alluded to, south-east of the Straits of Babel-mandeb, were the intermediate stations between the peninsula of India and the east of Africa for the Jewish and Phœnician trade. Here the Indians had settled from the earliest times, as it was a coast opposite their native country, and the sailors to Ophir might find in the basin of the Indian Erythræan Sea, other sources of gold besides India itself.

The gloomy and austere Etruscan race do not appear to have been as influential, or to have extended the circle of our acquaintance with geography so much, as the Phœnicians, and they were early subject to the Grecian influence of a stream of Tyrrhenian Pelasgi. They carried on no inconsiderable trade by land through the north of Italy, and across the Alps, where "the sacred road (44)" which was preserved by all the neighbouring nations, led to the distant amber countries. By the same road, the Rasenna, the aboriginal race of Tuscans, appear to have passed out of Rhætia to the river Po, and even still further southwards. The influence which the public life of the Etrurians exerted upon the political institutions of ancient Rome, and through these upon the entire life of the people, is of the utmost importance in regard to the position which we have assumed, for the purpose of considering the subject in the most general and complete manner. We may say that such an influence (in as far as it has advanced the civilization of mankind through the

medium of the Romans, or at least left its impression upon after centuries) still exerts, in its ultimate and most distant manifestations, a political bias even at the present day ([45]).

A peculiar characteristic of the Etrurian race, and one which I must especially mention in this place, was their inclination to a close intimacy with natural phenomena. Their divinations (the occupation of a noble caste of priests) caused them daily to observe all meteorological occurrences. The interpreters of the lightning (Fulgatores) occupied themselves with examining the direction of the lightning and with "drawing it down" and "turning it aside ([46])." They distinguished carefully between flashes of lightning from the higher regions of the clouds, and those which Saturn, "the God of the earth ([47])," caused to arise from below, and which they called terrestrial lightning of Saturn, a difference which more modern natural philosophy has again thought worthy of especial attention. In this way complete registers of the daily condition of the weather were established ([48]). Also the art of examining water (Aquælicium), and of drawing forth springs practised by the "Aquileges," gave origin to a careful investigation of natural signs, of the strata of the rocks and the inequalities of the earth. Diodorus, on this account, extols the Tuscans as a people addicted to the study of Nature. To this praise, I will add that the noble and powerful sacerdotal race of the Tarquins present to us the rare specimen of favour shown to the possession of physical knowledge.

Before coming to the Greeks and the most highly gifted races, in whose civilization our own is most deeply rooted, and from whose traditions we obtain an important

part of our earlier acquaintance with the History of the World and the Phenomena of Nature, we have mentioned the ancient seats of culture in Egypt, Phœnicia and Etruria. We have examined the basin of the Mediterranean with its peculiar form and position, and the influence of these relations upon the commercial intercourse with the western coast of Africa, with the furthest north, and the Arabian and Indian Seas. In no point of the earth have there been more changes of power, or of active life under the direction of the mind. The impulse has propagated itself widely and continuously through the Greeks and Romans, especially since the latter broke the power of the Phœnicians and Carthaginians. That which we call the commencement of history is only the beginning of self-consciousness among later generations. It is one of the advantages of our times that, by the splendid progress in the general and comparative study of languages, by the careful search after monuments and their accurate interpretation, the scope of the historical inquirer is daily enlarged, so that by gradual steps a higher antiquity is beginning to be made manifest to our eyes. Besides the civilized races upon the Mediterranean which I have above brought forward, many other nations show traces of ancient culture; in western Asia, the Phrygians and Lycians; in the farthest West the Turduli and Turdetani (49). Of these Strabo says, "they are the most civilized of all Iberians, and make use of the art of writing; they possess written books of former epochs, and poems and laws in verse to which they attribute the age of six thousand years." I have dwelt upon these particular examples in order to record how

much of ancient civilization, even of an European people, has disappeared without leaving a trace behind, and how the earliest history of the survey of the earth is restricted to a very narrow basis.

Beyond the forty-eighth degree of latitude, north of the Sea of Azoph and the Caspian, between the Don, the Volga and the Jaik, where the latter flows among the southern Ural Mountains so rich in gold, Europe and Asia are continuous with one another through the medium of flat moors. Herodotus, and also Pherecydes of Syros, considered all the northern Scythian part of Asia (Siberia) as belonging to the Sarmatian part of Europe (50), indeed as being a portion of Europe itself. Towards the south, our quarter of the globe is distinctly separated from Asia; but the prominent peninsula of Asia Minor and the varied Archipelago of the Ægean Sea (like a bridge of nations between two quarters of the earth) have afforded an easy mode of communication for the races of mankind, their languages and customs. Western Asia has been, from the earliest times, the great highway for the people wandering from the East, as the north-west of Greece was the high road for the advancing Illyrian races. The islands of the Ægean, which have been partly subject to Phœnician, Persian and Grecian dominion, were the intermediate steps between Greece and the most distant East.

The contact between the nations, which took place when the Phrygian kingdom was united to the Lydian, and the Lydian to the Persian, served to extend the range of ideas both of the Asiatic and the European Greeks. The Persian Empire, by means of the warlike undertakings

of Cambyses and Darius Hystaspes, extended from Cyrene and the Nile, as far as the fruit-country of the Euphrates and the Indus. A Greek, Scylax of Karyanda was employed to explore the course of the Indus from the district of Cashmere (Caspapyrus) ([51]), as far as its mouth. The intercourse between the Greeks and Egyptians, (between Naucratis and the Pelusian mouth of the Nile), was free, even before the Persian conquest; it was so even in the time of Psammetichus and Amasis ([52]). The relations which I have here represented, enticed many Greeks from their native soil, not only in the foundation of distant colonies, of which I shall presently make mention; but also to serve as hired soldiers in foreign armies in Carthage ([53]), Egypt, Babylon, Persia and the Bactrian country of the Oxus.

A deeper insight into the individuality and characteristics of the various Grecian races, has shewn us that among the Dorians, and to a certain extent also among the Æolians, there was an earnest and almost unsocial spirit of seclusion, and that we must, on the contrary, ascribe to the cheerful Ionian races a habit of life continually excited, with reference to internal and external objects, by desire of investigation and by activity. Led on by an observant disposition, and fancifully adorned with poetry and art, the Dorians, wherever they have been implanted as colonies, have scattered abroad vigorous seeds of progressive civilization.

The character of the Grecian landscape ([54]) was possessed of the peculiar charm of an intimate union of land and water; and the varied form of the country, which was due to such an union, must have induced the Greeks at

an early date to practise navigation, and to establish active commercial intercourse and contact with foreign nations. After the dominion of the sea by the Cretans and Rhodians, came the expeditions of the Samians, Phoceans, Taphians and Thesprotians, commencing, indeed, with a view to kidnapping and plunder. Hesiod's aversion to a sea-faring life only testifies his own individual opinion, or the timidity of ignorance in nautical matters which was seen at the commencement of civilization in the mainland of Greece. On the other hand, the oldest traditions and fables referred to distant wanderings and sea voyages, just as if the youthful fancy of man delighted in the contrast between the creations of the fancy and their limited real experience; as for example the march of Dionysius and Hercules (Melkarth in the temple at Gadira), the wandering of Io [55], and of Aristeas who reappeared so frequently, of the Hyperborean magician Abaris, whose arrow [56] (his means of transporting himself from one place to another) has been supposed to signify a compass. In these wanderings, events and ancient views of the earth mutually reflect one another, and the continual change of the latter react again upon the province of history and fables. In the voyages of the heroes returning from Troy, Aristonicus makes Menelaus sail round Africa more than five hundred years before Neko [57], and extends his voyage from Gadira to India.

In the periods of which we are here treating (in Greece before the Macedonian campaign to Asia) there are three events which have had an especial influence in extending the sphere of observation and the survey of the earth among the Greeks. The events are, the attempts to

spread beyond the basin of the Mediterranean towards the East and the West, and the establishment of numerous colonies from the Straits of Hercules to the north east shore of the Euxine; and these colonies were more varied in their political constitutions, and more effective in promoting the advance of intellectual civilization than those which were founded by the Phœnicians and Carthaginians in the Ægean Sea, in Sicily, Iberia and the northern and western coasts of Africa.

The advance towards the East, about twelve centuries before our era, and a hundred and fifty years after Ramses-Miamun (Sesostris), when considered merely as an historical event, is called "the Expedition of the Argonauts to Colchis." The real occurrence, which is clothed in fables, (that is, which is mixed up in its narrative with ideal beings and productions of the fancy) is simply the fulfilment of a national endeavour to explore the inhospitable Euxine. The traditions respecting Prometheus and the unfettering of the Titan, who obtained fire from Heaven upon Mount Caucasus in Hercules' eastern journey, the ascent of Io out of the valley of the Hybrites (58), near Caucasus, the fables of Phrixus and Helle, all indicate the same direction, namely the endeavour to advance into the Euxine Sea, whither the Phœnician ships had already ventured.

Before the migrations of the Dorians and Æolians, the Beotian town of Orchomenus, near the northern extremity of the Lake Copais, was a rich commercial city of the Minyans. The voyage of the Argonauts, however, commenced at Iolkos, the chief settlement of the Thessalian Minyans in the Bay of Pagasæ. The

locality of the tradition, the goal and farthest point attained during the expedition [59], has been variously represented in different times, and instead of the indefinite distant land Æa, it has been fixed at the mouth of the river Phasis (Rion), and at Colchis, a seat of ancient civilization. The sailors of the Milesians and their numerous colonial towns upon the Euxine, obtained a closer acquaintance with the eastern and northern boundaries of the sea. They gave distinct outlines to the geographical parts of their fable. At the same time an important series of new prospects opened themselves. The western shore of the neighbouring Caspian Sea had been known for a long time; but even Hecatæus considered it as the coast [60] of an eastern ocean which encircled the earth. The venerable father of history himself, taught (and the point was again contested for six hundred years afterwards, until the time of Ptolemæus), that the Caspian Sea is a basin, surrounded upon every side.

A wide field for the study of the races of mankind was also disclosed in the north-eastern angle of the Euxine. Men were astonished at the varied languages of the different nations [61], and felt strongly the want of interpreters, the first rude instruments in the comparison of languages. Their trade led them from the Lake Mæotis, which they considered to be very extensive, through the moors, where, at the present day, the Kirghises tend their flocks, through a chain of Scythian and Scolotian races, whom I consider to be of Indo-Germanic [62] origin, from the Argippæi and Issedonians to the Arimaspias [63] with its golden sands, upon the northern declivity of Mount Altai. Here is the

ancient "kingdom of Old Men," the seat of the meteorological fable (64) of the Hyperboreans, who came with Hercules far into the West.

We may suppose that the part of northern Asia, which I have above alluded to, and which in our days has again become so famous in consequence of the Siberian gold-washing, and the gold amassed by the Massagetes (of Gothic extraction) in the time of Herodotus, were important sources of wealth and luxury for the Greeks, through their commerce established in the Euxine. I place these sources between the 53rd and 55th degree of latitude. The region of the gold-dust, however, of which the Daradas (Darder, or Derder), mentioned in the Mahabharata, and in the fragments of Megasthenes, gave account to the travellers, and to which, from an accidental similarity with the name of an animal (65), the often repeated fables of the giant-ants has been connected, is in the 35th and 37th degree. It falls, according to a double calculation either in the Highlands of Tibet, east of the mountain chain of Bolor, between the Himalaya and Kuen-lün, west of Iscardo, or north of Kuen-lün, towards the desert which the accurate Chinese observer and traveller Hiuen-tshang (in the beginning of the seventh century of our era) has also described as being productive of gold. How much more accessible must the northern gold country of the Arimaspians and Massagetes have been to the trade of the Milesian colonies on the north-eastern coast of the Euxine. It appears to me to be necessary in our history of the contemplation of the earth, to touch upon everything which may be considered as an important consequence (and one productive of

results even in later years) of the navigation of the Euxine and the first advance of the Greeks into the east.

The great and pregnant event of the Dorian migration, and the return of the Heraclidæ into the Peloponesus, happened about a century and a half after the semi-fabulous expedition of the Argonauts, that is, after the Euxine was opened to Grecian navigation and commerce. This navigation, occurring at the same time as the formation of new states and political constitutions, gave the first impulse to the establishment of settlements; a colonial system which represents an important epoch in the life of the Grecian nation, and has been most effective in extending a view of the world founded upon intellectual civilization.

The close union between Europe and Asia has been chiefly founded upon the establishment of colonies. They formed a chain from Sinope, Dioscurias and the Taurian Panticapæum as far as Saguntum and Cyrene, colonized from the arid island of Thera.

No nation of the Old World possessed more numerous, and in proportion to their number, more powerful colonial towns than the Greeks. From the establishment of the most ancient Æolian colonies, among which Mytilene and Smyrna were distinguished, to the founding of Syracuse, Croton and Cyrene, from four to five hundred years elapsed. The Indians and Malays attempted only some weak settlements on the eastern coast of Africa, in Zocotora (Dioscorides), and in the southern Asiatic Archipelago. Among the Phœnicians, however, there was a very completely organised colonial system extended over a wider sphere than that of the Greeks, for with a very

wide interval between the stations, it reached from the Persian Gulf to Cerne on the western coast of Africa. No country has sent out a colony so powerful in respect of conquests, and of commerce at the same time, as Carthage. But in spite of its greatness, in point of intellectual civilization and artistic culture, Carthage was far inferior to the Grecian colonial cities, which flourished so gloriously and continuously with their scientific attainments.

We must not forget that many populous Grecian cities flourished in Asia Minor, in the Ægean Sea, in southern Italy and Sicily at the same time; that, like Carthage, the colonial states of Miletus and Massilia founded others; that Syracuse, when at the highest pinnacle of its power, fought against Athens, and the armies of Hannibal and Hamilcar; that Miletus, after Tyre and Carthage, was for a long time the first trading city in the world. Whilst so varied and active a life was spread abroad through the energy of a single people, who were so frequently shaken by internal convulsions, new germs of the national development of the intellect were everywhere called forth by their increased prosperity and by transplanting their native civilization. The bond of a common language and the same religion united their most distant members. By these means the little mother country of Greece extended itself into the wide sphere of life of other nations. Strange elements were taken up without abstracting from Greece any of its great and independent character. The impression of its contact with the East, and, more than a hundred years before the invasion of Cambyses, with Egypt, which had not as yet assumed Persian customs, was

nevertheless, in its nature much more lasting than the influence of the settlements of Cecrops from Sais, of Cadmus from Phœnicia, and of Danaus from Chemmis, which have been so much contested and are enveloped in such deep obscurity.

The point in which the Grecian colonies differed from those of all other nations, especially from those of the ungraceful Phœnicians, and which pervaded the entire organization of their commonalty, arose from the individuality and original difference of the races into which the nation was divided. In the colonies, as in the whole of Greece, there was an intermixture of combining and dividing influences.

These contrasts gave rise to a multiplicity in the direction of their ideas and feelings, to differences in their modes of expression, and in the art of music; they testified everywhere the rich fulness of life, where that which is apparently adverse according to the laws of Nature, becomes gentle and harmonious.

Although Miletus, Ephesus and Colophon were Ionian; Cos, Rhodes and Halicarnessus, Dorian; Croton and Sybaris, Achaian; yet in the midst of this diversity of origin, indeed even in southern Italy, where colonial towns of the various races were situated near to one another, the power of the Homeric verses, and the enthusiastic influence of their language united them by the charms of their fascination. With the deep contrast in their manners, and in their political constitutions, and with the changing agitations which occurred in their states, Greece still preserved itself entire. An extensive range of typical ideas of art pervading every single race, was considered as the property of the entire nation.

It remains for me still in this section to mention the third point, to which I have above alluded as especially influential in the history of the view of the world, besides the discoveries in the Euxine and the establishment of colonies along the border of the Mediterranean. The founding of Tartessus and Gades, where a temple was dedicated to the wandering god Melkarth (a son of Bal), and the colonial city Utica, older than Carthage, remind us that the Phœnicians had navigated the open sea for many centuries, whilst the straits, which Pindar (66) called the gates of Gadira, were still closed to the Greeks. Thus, as the Milesians established connections with the East through the discovery of the Euxine (67), and by their means the land traffic with the northern European and Asiatic nations, and in much later years with the people of the Oxus and Indus was kept alive; so among the Grecian tribes, the Samians (68) and Phoceans (69) first attempted to advance out of the basin of the Mediterranean towards the West.

Colæus of Samos wished to sail to Egypt, where at that time the traffic (probably only renewed) with the Greeks had been commenced under the reign of Psammetichus. He was driven by easterly storms to the Island of Platæa, and thence (Herodotus adds significantly, "not without divine intervention") through the straits into the ocean. It was not only the accident of an unexpected increase of traffic with the Iberian Tartessus, but the discovery in point of locality, and the entrance into a world unknown, and only anticipated in fables, which gave the event such importance and fame wherever the Grecian language was understood in the Mediterranean. Here, upon the other side of the Pillars of Hercules (formerly

called the Pillars of Briareus, of Ægeon and Cronos) on the western border of the world, on the way to Elysium and the Hesperides, the waters of the encircling ocean (70) in which at that time all rivers were thought to arise, were for the first time seen.

At Phasis again, the navigators had arrived at the coast bordering the Euxine, beyond which they fancied there was a Lake of the Sun; south of Gadira and Tartessus they looked upon the boundless sea. This circumstance gave to the gates of the Internal Sea, a peculiar importance for fifteen hundred years. Always striving to reach some further country, sea-faring nations, one after another, Phœnicians, Greeks, Arabians, Catalonians, the inhabitants of Majorca, France (from Dieppe and La Rochelle), Genoese, Venetians, Portuguese and Spaniards made attempts to advance into the Atlantic Ocean, which was always considered a boisterous, shallow, cloudy and gloomy sea (mare tenebrosum); until the southern people, as it were by stations, from the Canary Islands and the Azores, at last reached the New Continent, which the Normans had already accomplished in another way and at a much earlier period.

At the time when Alexander was exploring the East, considerations concerning the form of the earth had already led the great philosopher of Stagira (71) to the idea of the proximity of the Indies to the pillars of Hercules; indeed, Strabo anticipated so much, "that in the northern hemisphere, perhaps in the parallel circle which passes through the pillars of Hercules, the island of Rhodes and Thinæ, between the shores of the west of Europe and of the east of Asia, *many other inhabited continents of land* (72)

may exist." The idea of such a locality in a continuation of the long axis of the Mediterranean was connected with a grand view of the earth by Eratosthenes (generally and extensively known among the ancients), according to which the entire ancient continent, in its widest expanse from west to east, in the parallel of about thirty-six degrees, presents an almost unbroken line of elevation ([73]).

But the expedition of Colæus of Samos indicates, not only an epoch in which a new prospect of more extended nautical undertakings was presented to the Greeks and to the nations who inherited their civilization; it enlarged immediately the circle of their ideas.

A great natural phenomenon, which rendered the connection of the earth with the moon and the sun perceptible to them in the periodical swelling of the sea, began from this time to attract continually their attention. In the African Syrtes, the phenomena appeared to the Greeks with less regularity, and had occasionally been a source of danger to them. Posidonius observed the ebbing and flowing of the tide at Ilipa and Gadira, and compared his observations with what the more experienced Phœnicians could communicate to him respecting the influence of the moon.

II.—CAMPAIGNS OF THE MACEDONIANS UNDER ALEXANDER THE GREAT—TRANSPOSITION OF THE RELATIONS OF THE WORLD—UNION OF THE WEST WITH THE EAST—GREECE PROMOTES THE INTERMIXTURE OF RACES FROM THE NILE TO THE EUPHRATES, THE JAXARTES AND THE INDUS—SUDDEN EXTENSION OF THE VIEW OF THE EARTH BY THE OBSERVATION OF NATURE AND THE INTERCOURSE WITH ANCIENT CIVILIZED TRADING NATIONS.

In the course of development of the History of Man, as far as it represents a close union of the west of Europe with the south-west of Asia, with the valley of the Nile and Libya, the campaigns of the Macedonians under Alexander the Great, the destruction of the Persian empire, the commencing intercourse with western India and the influence of the Grecian and Bactrian kingdom, which lasted a hundred and sixteen years, indicate one of the most important epochs. Though the sphere of development, in point of space, was almost immeasurably extended, yet, in addition, it grew in intensity of moral grandeur, by the indefatigable attempts of the Conqueror to mix all the nations, and to establish an unity in the

world, under the spirited influence of Greece (75). The foundation of so many new cities in places, the choice of which proves an exalted purpose; the arrangement and subdivision of an independent commonalty for the government of these towns, and the tender forbearance from disturbing national customs and native civilization, all testify that the plan of a great and completely organized system had been laid down. That which perhaps originally did not belong to this plan, developed itself afterwards, as is always the case in the midst of comprehensive events, from the nature of the relations between the countries. Now, if we remember, that from the battle of the Granicus to the destructive incursion of the Sacæ and Tochari into Bactria, only fifty-two Olympiads elapsed, we are astonished at the duration and the almost magic power of the Grecian civilization imported from the West. When it had been combined with the knowledge of the Arabians, the Persians and Indians, it exercised its influence even down to the Middle Ages; so that it often remains doubtful as to what originally belonged to Grecian literature, and what was the genuine production of the spirit of the Asiatic people.

The principle of union or unity, or rather the perception of the beneficial political influence of such a principle, was, as all the arrangements of his government testify, deeply fixed in the mind of the bold conqueror. He was himself inclined towards Greece, and it had been early impressed upon him by his great teacher. We read in Aristotle's (76) politics: "There is no want of activity of spirit, or skilfulness in the arts, among the Asiatic nations; yet they live despondingly, in subjection and servitude; whilst the Greeks, powerful and quick, living in freedom, and there-

fore well governed, were united into one state, capable of ruling over all barbarians." Thus wrote the philosopher of Stagira, during his second residence in Athens, (77) before Alexander has passed over the Grancius. The fundamental principles of the teacher, "however unnatural their unlimited kingdom (the παμβασιλεία) must have appeared to him," doubtless made a more lively impression upon the conqueror than the fanciful reports of Ctesias concerning the Indians, to which Augustus William von Schlegel, and before him St. Croix, attributed so great an effect (78).

In the foregoing section I have represented the sea as an element which lies between the different nations, but at the same time, connects them. I have in a few words delineated the extent of their navigation, which was so much increased by the Phœnicians, Carthaginians, Tyrrhenians, and Tuscans. I have shown how the Greeks, strengthened in their naval power by their numerous colonies, attempted to advance out of the Mediterranean towards the East and the West, by the voyage of the Argonauts from Iolcus, and by Colæus of Samos, and how the fleets of Solomon and Hiram towards the south, in their voyages to Ophir, visited the distant gold-countries, through the Red Sea. The second section brings us principally into the centre of a great continent, in the way open to land traffic, and the navigation of rivers. In the short space of twelve years, the following events occurred in this order: the campaign in Western Asia and Syria, with the battle at the Granicus and in the grand passes of Issus; the taking of Tyre and the easy subjugation of Egypt; the Babylonian and Persian campaign, when the

sway of the Achæmenides was overturned at Arbela (in the plains of Gaugamele); the expedition to Bactria and Sogdiana, between the Hindu Kho and the Jaxartes (Syr); lastly, the bold incursion into the land of Five Rivers (Pentapotamia) of Western India. Alexander founded Grecian settlements almost everywhere, and spread abroad Grecian customs in the immense tract of land of the temple of Ammon in the Libyan Oasis, and from Alexandria upon the western Delta of the Nile, as far as the northern Alexandria upon the Jaxartes (the present Khodjend in Fergana).

The extension of the sphere of ideas (and this is the point of view from which we must contemplate the enterprise of the Macedonians, and the long existence of the Bactrian kingdom) was founded upon the vastness of the space of the new country, upon the difference of climate between Cyropolis on the Jaxartes, (in the same latitude as Tiflis and Rome), the eastern Delta of the Indus, and Tira, under the tropic of Cancer. We must add to this the wonderfully varied form of the surface of the earth, ornamented by luxuriant fruit countries, wildernesses, and snow-capped hills; the novelty and gigantic size of the productions of the animal and vegetable world; the appearance and the geographical distribution of the differently coloured races of mankind; actual intercourse with the partially endowed and anciently civilized natives of the East, with their religious fables, their systems of philosophy, their knowledge of astronomy, and their astrological fictions. In no other period of time (excepting that which, eighteen centuries and a half later, witnessed the important event of the discovery and

exploration of tropical America) have a richer fulness of new natural views, and a greater amount of materials for the establishment of a physical acquaintance with the earth, and the study of comparative ethnology, been at once afforded to any part of the human race. The whole of the literature of the West testifies the strength of the impression which such an expansion in our views produces: it is also displayed (as is everything which calls forth the powers of our imagination in the description of beautiful natural scenery) by the doubts which have been raised by the Grecian and after them the Roman authors, in the reports of Megasthenes, Nearchus, Aristobulus, and other followers of Alexander. These reporters, influenced by the colouring and prejudice of their age, and interweaving closely matters of fact with the opinions of individuals, experienced the changing fate of all travellers—the alternation between bitter censure and indulgent vindication of later times. The latter has in our days become so much the more frequent, as a deep study of the Sanscrit language, a general acquaintance with native geographical names, the examination of Bactrian coins discovered in the Topes, and especially a survey of the country with its organic productions, have afforded elements of correct judgment which were unknown to the severe and condemnatory Eratosthenes, or to Strabo and Pliny, who took only one-sided and partial views.(79)

If according to the degree of longitude, we compare the entire extent of the Mediterranean, with the distance from east to west, which separates Asia Minor from the shores of the Hyphasis (Beas), and the "Altars of Return," we must admit that the geographical knowledge of the

Greeks was more than doubled in a few years. In order to define more closely that which I called 'Materials for Physical Geography and Natural History,' which have been so much multiplied by Alexander's campaigns and new cities, I must first record the recently collected facts respecting the particular form of the earth's surface. In the countries through which his armies passed, the low lands (wildernesses or salt moors without vegetation, as on the north of the Chain of Asferah, a continuation of Thian-shan, and the four wide cultivated districts of the rivers Euphrates, Indus, Oxus and Jaxartes) presented a strong contrast to the Snowy Mountains of nearly 19000 feet in height. The Hindu-Kho or the Indian Caucasus of the Macedonians, a continuation of the north Tibetan Kuen-lün, west of the transverse southern mountain range of Bolor, turning towards Herat, is divided into two chains which border Kafiristan (80); the southern chain is the principal one. Alexander went over the table land of Bamian, 8000 feet in elevation, where the Cave of Prometheus (81) was seen, and passing along the ridge of Kohibaba, and beyond Kabura, along the River Choes, crossed the Indus somewhat to the north of Attok of the present day. A comparison of the low mountain of Taurus, which the Greeks well knew, with the eternal snows of Hindu-Kho, which at Bamian, according to Burnes, begin at the altitude of 12200 feet, must have given them cause to recognise on a grand scale the varieties in the climate and the zones of plants lying one above the other. In active minds, that which the elements of Nature presents immediately to the senses produces a deeper and more

lasting impression. Strabo describes in a lively way their passage over the mountainous country of the Paropamisadæ, where the army with difficulty made a road through the snow, and where all vegetation ceased (82).

All their previous acquaintance with the productions of India and of the skill of its natives, through commercial intercourse, or from the reports of Ctesias of Cnidus, who lived at the Persian court for seventeen years in the capacity of physician to Artaxerxes Mnemon, was very imperfect or almost nominal, but from the settlements of the Macedonians, more accurate information was diffused throughout the West. We refer to the well-watered rice fields, of the cultivation of which Aristobulus has given a special account; to the cotton plant affording materials for their finely woven fabrics and for paper (83); spices and opium; wine made from rice and the juice of the palm, the Sanscrit name for which "Tala," has been preserved by Arrian (84); sugar from the sugar cane (85), often confounded in Grecian and Roman authors for the juice of the bamboo (86); shawls from the wool of the Tibet goats, silken wares (87); oil from the white sesame (Sanscrit tila); oil of roses and other fragrant articles; gum-lac (Sanscrit lâkschâ, in the common language, lakkha) (88); and lastly, the hard Indian steel.

Besides the actual acquaintance with these products, which soon became a considerable object of commerce, and many of which were transplanted by the Seleucidæ (89) into Arabia, the view of so richly adorned tropical nature, excited a more intellectual kind of pleasure in the Greeks. Great and hitherto unseen animals and trees, filled their

imaginations with exciting pictures. Authors, whose bare scientific style of writing was otherwise devoid of all spirit, became poetical in describing the habits of the "elephants, the height of the trees, whose summits cannot be reached with an arrow, whose leaves were larger than the shield of an infantry soldier;" or in picturing the Bambusa, a light feathery tree grass "whose single joints (internodia) served as canoes for four rowers," the Indian fig-tree which takes root by its branches, whose stem is as much as twenty-eight feet in diameter, and as Onesicritus very naturally expresses himself, "forms a leafy arbour like a tent with four pillars." The lofty tree ferns, in my opinion, the fairest ornament of tropical climates, are never mentioned by Alexander's companions (90), but they noticed the splendid fan-like palms, and the delicate evergreen of the plantations of the Pisang bushes (91).

The knowledge of a great part of the surface of the earth was now for the first time attained. The world of actual objects opposed with overwhelming power their internal ideas: and whilst by Alexander's conquests, Grecian language and literature were widely spread and produced great results, scientific observation, and the systematic arrangement of general knowledge, were rendered clear to the mind by means of Aristotle's teaching and representations (92). We here point out a happy coincidence of events; for exactly in that age in which suddenly an immense store of new materials was presented to man's perceptions, the intellectual working of the subject was facilitated and multiplied by the direction which the Stagirite gave simultaneously to empirical inquiry into the facts of Natural History, to the depths of

speculative investigations and to the improvement of a clear and definite scientific language. Thus Aristotle remains even after thousands of years, as Dante well expresses it, "il maestro di color che sanno (93)."

The belief in an immediate increase in Aristotle's zoological knowledge by means of the campaign of the Macedonians, has nevertheless, from strict modern inquiries, if not altogether disappeared, at any rate been much shaken. The meagre compilation of a life of the philosopher of Stagira, which was for a long time attributed to Ammonius, the son of Hermias, has, among other historical errors, also spread abroad this opinon (94): that the philosopher accompanied his pupil, at any rate as far as the banks of the Nile (95). The great work upon animals appears to be but little more recent than the *Meteorologica,* and this, according to internal evidence, appeared in the 106th, or at latest in the 111th Olympiad; thus, either fourteen years before Aristotle came to the court of Philip, or, at any rate, three years before the passage across the Granicus. Against this view of an early completion of the nine books of Aristotle's history of animals, some separate facts were brought forward. Among these is the accurate acquaintance which Aristotle appeared to have with the elephants, the bearded stag (*Hippelaphos*), the Bactrian camels, with two humps, the Hippardium, which was taken for the hunting tiger (Guepard), and of the Indian buffalo, the latter of which was first brought into Europe in the time of the Crusades. We must, however, remark, that the native country of this remarkably large stag, with the horse's main, which Diard and

Duvaucel sent from the East Indies to Cuvier, and which he called the *Cervus Aristotelis*, according to the sketch of the philosopher himself, is not the Indian Pentopotamia, through which Alexander went, but Arachosia, a tract of country west of Candahar, which, with Gedrosia, made up an ancient Persian satrapy ([97]).

Is it not probable that these short accounts respecting the habits of the above-named animals were handed down from Persia and Babylon, independently of the Macedonian campaign? With their entire ignorance of the preparation of alcohol ([98]), only skins and bones, and not the soft parts capable of dissection, could be sent from the remote regions of Asia to Greece. It is also very probable that Aristotle had the greatest assistance from Philip and Alexander in forwarding his physical studies, and his descriptions of Nature, in collecting together a vast number of zoological materials from the whole of Greece, and from the Grecian seas, and in founding the only library of his time, which was handed down to Theophrastus, and afterwards to Neleus of Scepsis; and the present of eight hundred talents, and the maintenance of so many thousand collectors, overseers of fishpools, and keepers of birds, are to be looked upon only as later exaggerations ([99]), and misunderstood traditions of Pliny, Athenæus, and Ælian.

The Macedonian expedition, which laid open so great and beautiful a part of the earth to the influence of a single highly cultivated nation, may, in the truest sense of the word, be looked upon as a *scientific expedition*, and as the first in which a conqueror had sur-

rounded himself with learned men from all the departments of science, with natural historians, geometricians, historians, philosophers and artists.

Aristotle not only examined that which originated from his own mind, but also all that the labours of the talented men of his school, who accompanied the army, brought to light. Among all these, the near relative of the Stagirite philosopher, Callisthenes, of Olynthium, was especially distinguished: before the march he had already written a botanical work, and an excellent anatomical description of the organ of vision. Owing to the earnest strictness of his manners, and the unmeasured freedom of his speech, he was hated by the princes who had already degenerated from their noble and simple customs, and also by their flatterers. Callisthenes undauntedly preferred freedom to life, when he was innocently involved in the conspiracy of Hermolaus and the nobility at Bactria, and was the unlucky cause of embittering Alexander against his former teacher.

Theophrastus, the warm friend and school-fellow of the Olynthian philosopher, had the honesty to defend him publicly after his fall. Of Aristotle we only know that before his departure he had recommended him to be prudent, and being experienced in the life of a courtier by his long sojourn with Philip of Macedon, had advised him "to speak as little as possible with the King, and if he must speak, always to speak courteously to him (100)."

With the assistance of men chosen from the school of Aristotle, Callisthenes, a philosopher already acquainted with Nature as she is seen in Greece, conducted the inquiries of his fellow labourers to higher views of the

newly opened and extensive spheres of observation. The richness of the vegetable world and the powerful race of animals, the form of the earth, or the periodical swelling of the great rivers could not alone attract their attention. Man and his different races, with their various gradations in colour and in habits, must, according to the peculiar expression of Aristotle (101) "appear as the central point of the entire Creation; as if the thought of the divine mind in him first attained consciousness." In the little which has come down to us of the reports of Onescritus, who was so censured in antiquity, we learn how much those who accompanied the Macedonian expedition wondered when they came into the distant East, at finding the Indian races dark coloured, and like Ethiopians as described by Herodotus, but without the curly hair of the African negroes (102): they closely observed the influence of the atmosphere upon the colour, and the different effects of dry and moist heat. In the earliest times of Homer, even long after the Homeridæ, the dependence of the warmth of the air upon the degrees of latitude and the distance from the poles was completely known; east and west at that time determined all the thermometrical meteorology of the Greeks. The tracts of the earth in the East were considered to be "nearer the sun, and to be the sunny region." The god in his course colours the skins of men with the dark hue of soot, and scorches and crisps their hair (103)."

Alexander's journey first gave an opportunity of comparing upon a large scale, the African races of mankind, especially congregated in Egypt, with the Arian nations on the other side of the Tigris, and the old Indian

original people who were very dark, but not curly haired. The division of mankind into varieties, their distribution upon the surface of the earth, more in consequence of historical events, than of long continued climatic influences, in places, where the types are once settled, and the apparent contradiction between their colour and habitation must to a great degree, have stimulated the inquiries of thoughtful investigators. In the centre of the great Indian country there is a wide district which was originally peopled by very dark, indeed almost black, inhabitants, very different from the lighter Arian people who poured in afterwards. To these belong the Vindhya nations, the Gonds, the Bhils, in the mountainous forests of Malava and Guzerat, and the Kolis of Orissa. The acute and learned Lassen considers it probable, that in the time of Herodotus, the black race of Asia, "the Ethiopians of the East," like the Libyans in colour of the skin, but not possessing the peculiarity of their hair, extended much further than they do now towards the north-west ([104]). In the same way in the ancient Egyptian kingdom, the proper woolly haired negroes, who were so often subdued, extended their places of abode far into the north of Nubia ([105]).

The results of ethnological comparison of languages as far as they are philosophical, independent of the original foundation of thought ([106]), or simply historical, were not used for the purpose of increasing our circle of ideas, by the view of many new physical phenomena, by contact with different races and their varied civilization. This kind of inquiry was unknown to the so-called classical antiquity. On the contrary, Alexander's expedi-

tion afforded to the Greeks scientific subjects which might be borrowed from the treasures amassed by earlier civilized people: I here especially bear in mind that together with the knowledge of the earth and its productions, the knowledge of the heavens was considerably advanced by intercourse with Babylon, according to more recent and deeper investigators. Indeed, by the conquest of Cyrus, the splendour of the astronomical sacerdotal colleges had already been established in the great city of the East.

The "step-pyramid" of Belus, (at the same time a temple, a tomb, and an observatory for examining the stars in the night), was given up to destruction by Xerxes; this monument, at the time of the Macedonian invasion, was already in ruins. But even though the distinct caste of priests was already dissolved, giving origin to various astronomical schools ([107]), it still became possible for Callisthenes (as Sulpicius supposes, by the advice of Aristotle), to send to Greece, accounts of observations on the stars during a long period, (Porphyry says, for a period of 1903 years before Alexander's entrance into Babylon, in the second year of the hundred and eleventh Olympiad.)

The most ancient Chaldean observations, which Almagest mentions (probably the oldest which Ptolemæus found applicable to his purpose), only extend to the seven hundred and twenty first year before our era, that is to the first Messenian war. It is certain "that the Chaldeans knew the motions of the moon with such accuracy, that the Grecian astronomers were compelled to make use of their ideas to establish their theory respecting the moon ([108])." Their observations also respecting the

planets, to which an innate love of astrology stimulated them, appear to have given rise to the actual construction of astronomical tables.

It is not my province here to decide how many of the earliest Pythagorean views, concerning the true nature of the construction of the heavens, the course of the planets and of the comets, which, according to Apollonius Myndius (109), return in long but regular succession, belonged to the Chaldeans. Strabo calls the Mathematician Seleucus," a Babylonian, and thus distinguishes him (110) from the Erythræan, who measured the tides. It is sufficient to remark, also, that the Grecian zodiac is very probably "borrowed from the Dodecatemoria of the Chaldeans, and that, according to Letronne's (111) important inquiries, it is of a date not earlier than the beginning of the sixth century before our era."

The immediate results of the intercourse between the Greeks and the nations of Indian origin, at the time of the Macedonian invasion, are enveloped in deep obscurity. With respect to science, it is probable that but little could have been gained, because Alexander passed through the region of the Five Rivers (in the Pantshanada) after having traversed the kingdom of Porus, between the Hydaspes clothed with cedar forests (112) (Jelum), and the Acesines (Tschinab), and only arrived as far as the Hyphasis; yet he reached the point where the latter river has already received the waters of the Satadru (Hesidrus of Pliny). The discontent of his soldiers, and fear of a general insurrection in the Persian and Syrian provinces, decided the generals who wished to advance as far eastward as the Ganges, to undergo the great catastrophe of

a retreat. The countries through which the Macedonians forced their way, were inhabited by almost uncivilized races. In the space between the Satadra and the Yamuna (the region of the Indus and the Ganges), an unimportant stream, the holy Sarasvati, forms an ancient classical boundary between the pure, noble, and pious worshippers of Brahma, in the east, and the mixed western races, who had no kings, and were not divided into castes ([113]). Hence Alexander did not advance as far as the seat of the highest Indian civilization. Seleucus Nicator, the founder of the great kingdom of Seleucidæ, first went from Babylon to the Ganges, and established political intercourse with the powerful Sandracottus (Tshandraguptas), by means of the numerous embassies of Megasthenes to Patali-putra ([114]).

In this way, an active and lasting union with the civilized parts of Madhya-Desa (the Middle Country), was first of all commenced. There were certainly in the Punjab (in Pentapotamia) learned Brahmins, who lived hermits' lives. But we do not know whether the splendid Indian system of numbers, in which a few figures obtain their value from position alone, was known to these Brahmins and Gymno-sophists, or whether, as is very probable, even at that time this system of calculation had been discovered in the most civilized parts of India. What a complete revolution would the world have experienced in the more rapid development and easier application of the mathematical signs, if before they willingly ascended the funeral pile, both Sphines (a Brahmin who accompanied Alexander's army, and was commonly called Calanus) and afterwards, in the time of Augustus, the

Brahmin Bargosa, had been able to communicate to the Greeks the Indian arithmetical system, in the way in which it came into so general use afterwards! The acute and comprehensive investigations of Chasles have shown us that the so-called method of the Pythagorean counting board (Abacus or Algorismus), as it is described in the geometry of Bœthius, is almost identical with the Indian system of calculation by position; but that method, for so long a time unproductive among the Greeks and Romans, was first generally used in the Middle Ages, especially when the insertion of the cypher replaced the plan of leaving an empty space. The most beneficial discoveries frequently require centuries to become acknowledged and completely understood.

III.—INCREASE OF THE VIEWS OF THE EARTH UNDER THE PTOLEMIES—THE MUSEUM AT SERAPEUM—PECULIAR CHARACTER OF THE DIRECTION TAKEN BY SCIENCE IN THIS EPOCH—THE SPREAD OF UNIVERSAL KNOWLEDGE—THE GENERALIZATION OF THE VIEWS OF NATURE IN THE EARTH AND IN THE HEAVENS.

After the dissolution of the Macedonian universal kingdom, including provinces in three continents, the germs which Alexander's system of government (that of closely uniting nations together in one common bond) had implanted in a fertile soil, began to take root, but in very different ways. The more the national peculiarities of the Grecian modes of thought disappeared, and their creative and spirited powers of imagination lost in strength and depth, so much more fruitful was their advance in the knowledge of the connection of phenomena, by means of the increased intercourse between the nations and the rational generalization of their views of Nature.

In the Syrian kingdom, among the Attalides of Pergamum, under the Seleucidæ and Ptolemies, they had the

advantage of distinguished rulers in every place at the same time. The Grecian Egyptians had the advantage of political union, and of a geographical position, which, from the situation of the Arabian gulf from Babel-Mandeb to Suez and Akaba (in the direction S.S.E. to N.N.W.) had the effect of bringing the trade of the Indian Ocean within a few miles of the Mediterranean shores ([115]).

The kingdom of the Seleucidæ did not enjoy the advantage of commerce which strengthened and organized the provinces of the Lagides; their position was exposed to danger, and menaced by divisions, the consequence of the varied nationality of the Satrapies. Traffic, in the kingdom of the Seleucidæ was rather internal, and confined to the banks of streams or the routes of caravans, and avoided all the powerful natural obstructions of snow-capped mountain chains, high-lands and deserts. The chief trade, in which silk was the most precious commodity, passed from central Asia, from the highlands of the Seres, north of Uttara-Kuru by the *Stony Tower* ([116]) (probably a fortified caravanserai), south of the source of the Jaxartes to the valley of the Oxus, upon the Caspian and Black Seas. On the other hand, the chief trade of the kingdom of the Lagides was, in the strict sense of the word, maritime, notwithstanding the free navigation of the river Nile, and the communication between its banks and the artificial roads along the shore of the Red Sea. According to Alexander's grand intentions, the newly founded city of Alexandria in Egypt and the ancient city of Babylon, were to be the principal places in the west and east of the Macedonian Empire; however, Babylon

never afterwards realized this hope, and the flourishing town of Seleucia, built by Seleucus Nicator, upon the lower part of the Tigris, and connected with the Euphrates by means of canals (117), contributed after the complete destruction of Babylon, to prevent the accomplishment of this hope.

Three great princes, the three first Ptolemies, whose reigns lasted a hundred years, by their love for the sciences, their splendid establishments for promoting intellectual development, and their unwearying endeavours to extend their commercial power, gave an impulse to the study of Nature and of geography, such as had not existed in any nation up to that time. The valuable possession of true scientific attainments, passed from the Greeks settled in Egypt, to the Romans. Even in the time of Ptolemy Philadelphus, scarcely half a century after the death of Alexander, and before the first Punic war had shaken the power of the aristocratic city of Carthage, Alexandria had become the greatest trading place in the world. The newest and most convenient way from the Mediterranean to the south-east of Africa, Arabia and India, was through Alexandria. The Lagides made use of the road for universal commerce, naturally marked out by the direction of the Arabian Gulf (118) with wonderful results; this route will again be made completely available only when the uncivilized condition of the eastern countries has improved, and the jealousy of the powers in the west has, at the same time, decreased. Even when Egypt became a Roman province, it was still the seat of immeasurable wealth, since the increasing luxury of Rome,

in the time of the Cæsars, reacted upon the Nile country, and the means of satisfying it were principally obtained from the commerce of Alexandria.

The important extension of the study of Nature and of acquaintance with geography, in the time of the Lagides, resulted from the trade, by means of caravans, into the centre of Africa through Cyrene and the Oases, from the conquests in Ethiopia and Arabia Felix under Ptolemy Evergetes, from the trade with the entire western continent of India, from the Gulf of Barygaza (Guzerat and Cambay) along the coasts of Canara and Malabar (Malayavara, district of Malaya), as far as the Brahman sanctuary of the promontory of Comorin (Kumari) ([119]), and the great island of Ceylon (Lanka in Ramayana; Taprobana, a native name, corrupted ([120]) by the cotemporaries of Alexander). Already at this date, Nearchus' laborious voyage, of five months' duration, along the coasts of Gedrosia and Caramania (between Pattala, on the mouth of the Indus, and the Euphrates) had materially contributed to the advance of navigation.

Alexander's companions were acquainted with the monsoon winds, which render such powerful assistance in voyages between the east coast of Africa and the north and west coasts of India. The Macedonian sailor Nearchus, in his endeavours to open the Indus for commercial purposes, examined the river between Nicæa, on the Hydaspes, and Pattala, for the space of ten months; he then hastened, at the beginning of October, (in the 3rd year of the 113th Olympiad), to sail away from the mouth of the Indus at Stura, because he knew that his voyage to the Persian Gulf would be assisted by the north-east and

eastern monsoon blowing along the coast, which runs in one parallel of latitude. Their acquaintance with this remarkable local law respecting the direction of the winds, afterwards gave the pilots courage to sail from Ocelis, at the straits of Babel-Mandeb, straight across the sea, to the great trading place of Malabar, Muziris (south of Mangalor), whither, by means of inland traffic, even the wares of the eastern coast of the peninsula of India, and the gold of the distant Chryse (Borneo?) were collected. The honour of bringing into use this new system of Indian navigation belongs to Hippalus, a sailor otherwise unknown, the date of whose voyages is very doubtful (121).

The history of the survey of the earth includes the narration of all the means by which nations have been drawn closer together, by which greater portions of the globe have become accessible, and the sphere of man's knowledge has been widened. One of the noblest of these means was the actual formation of a navigable route from the Red Sea to the Mediterranean by the Nile. At the point where the two continents, which are scarcely connected together, admit the waters of the sea to the farthest extent between them, Sesostris (Ramses Miamen), according to the representations of Aristotle and Strabo, or at any rate Necho (Neku), commenced the digging of a canal, but was frightened by some oracular words of the priests, and again gave it up. Herodotus saw and described one which had been completed, opening into the Nile, a little above Bubastus; it was the work of Darius Hystaspis, of the family of the Achæmenides. This canal having fallen into disuse, was afterwards so com-

pletely reconstructed by Ptolemy Philadelphus, that it kept alive the trade of Ethiopia, Arabia, and India, until the time of the Roman empire, until Marcus Aurelius, and probably as late as Septimius Severus, and this for more than four centuries and a half, even though it was not navigable at every season of the year, in consequence of its artificial contrivances for inclosing the water. For the similar object of promoting commerce in the Red Sea, the havens at Myos Hormos and Berenice were carefully built, and connected with Coptus by means of a splendid artificial road (122).

All these institutions and undertakings of the Lagides, both mercantile and scientific, depended upon an irresistible longing for that which is distant and single, and upon the idea of joining together nations, and forming a general and universal kingdom, and of comprehending the varied relations of the many different points of view from which they contemplated the world. This direction of the thoughts of the Greeks, which was productive of such great results and had been so long in a quiet state of preparation, was manifested in a noble way in Alexander's campaign, and his endeavours to unite the west with the east. Its extension during the time of the Lagides, characterizes the epoch which I am here describing; it may be considered as an important step in our acquaintance with Nature as a whole.

But since a manifold and widely extended prospect is necessary for the growth of our knowledge, the traffic of Egypt with distant countries and scientific journeys of discovery into Ethiopia, undertaken at the expense of the government (123), the distant pursuit of the ostrich or

elephant ([124]), or menageries of wild and rare beasts, in "the king's houses at Bruchium," might have had the effect of inducing a study of Natural History ([125]), and thus satisfy the claims of empirical knowledge; but the particular character of the Ptolemean age, and of the entire Alexandrian school, which preserved its peculiarity until the third or fourth century, was exhibited in another way; not so much in the actual observation of individual facts, as in the laborious examination of what had been for a long time collected, in arranging, comparing, and drawing logical results from the knowledge they already possessed. Now, up to the time of the important appearance of Aristotle, the phenomena of Nature had not been studied with the aid of any acute observations, and for their interpretation, they were surrendered to the dominion of the thoughts alone, or even to the power of arbitrary and obscure guesses and erring hypotheses; but from this date, a greater degree of attention to empirical knowledge was manifested. All the facts which they possessed were investigated and sifted. Natural Philosophy was less bold in its speculations and fanciful images; and by following the secure road of induction, approached more nearly to the nature of inquiring practical knowledge. An anxious desire to amass facts had rendered a manifold study of them necessary; and although the knowledge thus obtained produced good fruits in the works of some distinguished philosophers, yet in the degenerated imaginations of the Greeks, it was generally seen to be accompanied too often by spiritless and empty erudition. A want of attention to forms, and of life and spirit in their expressions, has also contributed to expose the learning

of the Alexandrian school to the severe sentence of future ages.

I must in this place bring forward, in a very prominent way, that which the Ptolemean age has accomplished by the aid of external relations, by the establishment and complete endowment of two important institutions: the Museum of Alexandria, and the two libraries at Bruchium (126) and at Rhacotes, and by drawing together, in the form of a college, so many learned men, who were possessed of vigorous and practical sense. The comparison of all that had been observed, and the generalization of their ideas of Nature, were rendered easy by their universal knowledge. The great scientific institution, which owed its origin to the first of the Lagides, preserved, among its many great advantages, this one particularly: namely, that its members were freely working in different directions (127), and though settled in a strange land and surrounded with all kinds of people, they nevertheless retained all that was characteristic of the Grecian mode of thought, and their Grecian acuteness.

According to the spirit and form of the history which I am writing, a few examples will be sufficient to point out how experience and observation became available under the protecting influence of the Ptolemies, in promoting the study of the phenomena of the earth and the heavens, and how a happy faculty of generalizing their views, and an industrious collection of materials were apparent in the direction taken in the Alexandrine age. But though the various schools of Grecian philosophy transplanted to Lower Egypt, gave rise in their oriental degeneracy to many fabulous interpretations

of the nature of things, yet the Platonic teachers (128) still retained in the Museum their mathematical knowledge, which was their firmest support. The advance of this branch of science included simultaneously, pure mathematics, mechanics and astronomy. The germ of all further progress in the natural sciences was to be found in Plato's high regard for the development of a mathematical mode of thought, and in Aristotle's view of Morphology, which included a notice of all organized beings. They were the guiding-stars which conducted the mind of man in safety throughout the fanatical errors of the dark ages, and prevented the utter loss of a healthy and scientific method of thinking.

The mathematician and astronomer, Eratosthenes of Cyrene, the most distinguished of the entire line of Alexandrian librarians, made use of the treasures which were at his disposal, in order to prepare a systematic "Universal Geography." He cleared the description of the earth from its fabulous traditions. He employed himself in the study of chronology and history, and separated the study of geography from its intermixture with historical scenes, which had before given it so much of its life and attractions. Their mathematical studies were compensated by their connection with inquiries concerning the varied form and extent of the continents, with geographical suppositions respecting the union of mountain chains, with the effects of floods, and the former watery covering of the dry land, which now bears all the traces of having been, at one time, the bottom of the sea. A belief in the overflowing of the Euxine, and the irruption

of the water through the Dardanelles, and the consequent opening of the strait between the Pillars of Hercules, induced the Alexandrine librarian, who favoured the theory of Strato of Lampsacus respecting the "System of Floodgates" ([129]) in the ocean, to undertake the important examination of the problem concerning the similarity of the level of the ocean around all the continents ([130]).

A stirring desire to arrive at general views, in consequence of the intellectual activity of the age, also gave rise to the first (Grecian) measurement of the degrees between Syene and Alexandria, that is, to Eratosthenes' attempt to determine, by approximation, the circumference of the earth. It is not the result he arrived at, upon the incomplete data of Bematist, which excites our interest; but his desire to raise himself out of the narrow limits of his native land, and to obtain a knowledge of the size of the globe.

A similar generalizing effort, in the age of the Ptolemies, is denoted by the splendid progress made in the scientific acquaintance with the heavenly bodies at that time. I may here allude to the determination of the position of the fixed stars by Aristyllus and Timochares, the earliest astronomers of the Alexandrine school; to Aristarchus of Samos, the cotemporary of Cleanthes, who was acquainted with the ancient Pythagorean ideas, and attempted to explore thoroughly the construction of the universe, who knew the immeasurable distance of the fixed stars from our little system of planets, and guessed at the double movement of the earth round its axis, and its progress round a central sun; to Seleucus of Erythræ, (or

Babylon) ([131]), who, a century afterwards, tried to confirm the opinion of the Samian writer, which had obtained but little credit; and to Hipparchus, the founder of scientific astronomy, and the greatest original observer of the stars in the whole of antiquity. Hipparchus was properly the first author of astronomical tables among the Greeks ([132]), and the discoverer of the precession of the equinoxes. His own observations upon the fixed stars were made at Rhodes, and not at Alexandria; and, upon comparing them with those of Timochares and Aristyllus, he was led to this great discovery, probably without the appearance of a new star ([133]); a long-continued observation of the rising of Sirius, might, indeed, have enabled the Egyptians to arrive at a similar result ([134]).

A peculiar and characteristic trait of the attempts of Hipparchus was his employment of phenomena in the heavens, for determining the geographical position of certain places. This connection of the study of the heavenly bodies with geography, and the reflection of one upon another, became an effective medium in advancing the grand idea of an universal acquaintance with Nature. The new map of the world, constructed by Hipparchus, and founded upon that of Eratosthenes, wherever the application of astronomical observations was possible, touches upon eclipses of the moon, and the measurement of shadows, for the determination of the geographical latitudes and longitudes. The hydraulic clock of Ctesibius, an improvement upon the water-glasses (Clepsydra), formerly in use, enabled them to measure *time* more accurately; whilst for the deter-

mination of *space*, from the date of the ancient dial and the scaphæ to the discovery of the Astrolabes, the solstitial rings, and the dioptric lines, better instruments were gradually afforded to the astronomers of the Alexandrine school. Thus, as it were by the aid of new organs, man attained, step by step, to a closer acquaintance with the movements of our planetary system. It was only the knowledge of the absolute size, form, and physical properties of these bodies, which, for thousands of years, made no progress.

Not only were many original astronomical observers of the Alexandrine Museum, distinguished geometers, but the age of the Ptolemies was more remarkable than any other, for the advance of mathematical knowledge. In the same century appeared Euclid, the founder of mathematics as a science, Apollonius of Perga, and Archimedes, who visited Egypt, and was connected with the school of Alexandria by Conon.

The long interval from the so-called geometrical analysis of Plato and the Menæchmean figures ([135]) to the age of Kepler and Tycho, Euler and Clairnut, d'Alembert and Laplace, represents a series of mathematical discoveries, without which, the laws of the motion of the heavenly bodies, and their mutual relations in the universe, could not have been known to mankind. As the telescope is an optical assistance to bring objects nearer to our senses, and to penetrate into the most distant space, so mathematical science, by enabling man to unite his ideas, has led the way into distant regions, and taken complete possession of

part of them; indeed, by the application of all the elements admitted by recent astronomers, in the present time which has been so effective in the extension of science, the eye of the mind has seen a heavenly body [136], and its place in the sky, its course and size have been marked out, before even a single telescope has been directed towards it!

IV.—THE DOMINION OF THE ROMANS—INFLUENCE OF AN EXTENSIVE EMPIRE UPON THE STUDY OF THE EARTH—ADVANCE OF GEOGRAPHY BY MEANS OF LAND TRAFFIC—STRABO AND PTOLEMÆUS—THE BEGINNING OF THE APPLICATION OF MATHEMATICS TO OPTICS AND CHEMISTRY—ATTEMPTS AT A PHYSICAL DESCRIPTION OF THE WORLD IN THE TIME OF PLINY—THE ESTABLISHMENT OF CHRISTIANITY GIVES RISE TO AND FAVOURS THE FEELING OF UNITY IN THE HUMAN RACE.

If we follow the course of the intellectual development of man, and of the gradual extension of his views respecting the earth, we come to the important epoch of the dominion of the Romans. We now, for the first time, find all the fruitful countries which surround the Mediterranean, united into a single state. Vast tracts of land, especially in the East, were added to it.

I must in this place again call to mind ([137]) how the picture which I am endeavouring to delineate in its general character, as a history of the survey of the earth, becomes, from the existence of such an empire, a single object of representation. Our civilization, that is, the

intellectual development of all the nations of the continent of Europe, may be looked upon as having arisen from that of the inhabitants of the shore of the Mediterranean, especially of the Greeks and Romans. That which we call, perhaps too exclusively, classical literature, obtains this title from the authors' acquaintance with the earliest origins of our knowledge, and with the first excitement of those ideas and feelings which were most closely connected with the spread of civilization, or the intellectual development of a nation([138]). In this mode of examining the subject, we consider as by no means unimportant, all the materials which flowed into the vast stream of Roman civilization, from the valley of the Nile, from Phœnicia, the Euphrates, or from India, arriving by ways not as yet explored with a sufficient degree of accuracy; but for these strange elements we are originally indebted to the Greeks, and to the Romans, surrounded as the latter were by Greeks and Etruscans. How late have we been enabled to investigate the great monuments of ancient civilized races, to interpret them and determine their relative antiquity! How lately have the hieroglyphic and cuneiform inscriptions been deciphered, by which, for thousands of years, armies and caravans have been passing, without even once guessing at their meaning!

The basin of the Mediterranean, with its two intersected northern peninsulas, was certainly the point whence the cultivation of reason and political knowledge radiated towards those nations, who now, we hope, possess the imperishable and increasing treasure of scientific attainments and of active industry, and who extended civilization, and with it, at first, slavery, but afterwards, involun-

tarily, freedom over another hemisphere; but in our hemisphere, as it were by the favour of our destiny, we still retain unity and variety, agreeably coupled together. The elements of civilization which we received were differently appropriated and transformed according to the distinct and contrasting peculiarities, and the individual mental endowments of the several races in Europe. Even on this side of the Atlantic Ocean, colonies and settlements, which have become free and mighty states, or at some time will be improved and organized, still preserve the reflection of these differences.

The Roman state, in the form of a monarchy, in the time of the Cæsars, considered with regard to its surface (139), was certainly, in point of mere extent, surpassed by the Chinese empire, in the dynasty of Tshin and the eastern Han (from thirty years before, to a hundred and sixteen years after our era), by the Mongolian Empire, in the time of Jingiskan, and by the present area of the Russian Empire in Europe and Asia; but, with the single exception of the Monarchy of Spain, as long as it was in possession of the New World, a larger tract of country, with all the advantages of climate, fertility, and position upon the earth, than the Roman Empire from the time of Octavius until Constantine, has never been united under one sceptre.

From the western end of Europe to the Euphrates, from Britain and a part of Caledonia to Getulia and to the borders of the Libyan coast, not only was the greatest variety in the forms of the earth, in its organic productions and physical phenomena, presented to the notice of the inhabitants, but also the human race was

seen in all the gradations of civilized and savage life, in the possession of ancient knowledge and in the exercise of ancient arts, as well as in the first dawning of the development of the intellect. Distant expeditions to the north and south, to the amber shores, and in the time of Ælius Gallius and Balbus, to Arabia and the Garamantes, were undertaken with very varied results. A general survey of the entire empire was commenced, under Augustus, by Grecian geometricians (Zenodoxus and Polycletus), and itineraries and special topographical accounts were prepared to be distributed among the rulers of the several provinces ([140]). This was done many centuries earlier in the Chinese Empire. They were the first statistical works undertaken in Europe. Roman roads, divided into miles, intersected many very extensive districts; and Hadrian, in an interrupted journey of eleven years' duration, visited his whole kingdom, from the peninsula of Iberia, to Judea, Egypt, and Mauritania. This great part of the world, which was subject to the sway of the Romans, was opened and rendered accessible to travellers: "pervius orbis," as the chorus ([141]) in the Medea of Seneca prophecies, with less justice, respecting the whole earth.

With the advantage of a long peace, we might perhaps have expected that the union into one monarchy of so extensive a country, and of such different climates, and the facility with which the officers of the state travelled through the provinces, with their numerous retinues of learned men, would have materially contributed to the advance of geography, as well as of natural history, and to the foundation of higher views respecting the relation

of various phenomena; but these great expectations have not been fulfilled. In all this lengthened period, when the Romans had undivided sway over the world, in nearly four centuries, Dioscorides the Cilician and Galenus of Pergamus were the only natural philosophers. The first considerably increased the number of species of plants, which had been described; but he stands far below the philosopher Theophrastus; while Galen, by the fineness of his dissections and the extent of his physiological discoveries, and by an accurate examination of numerous species of animals, "may be placed very near to Aristotle, and generally above him." Cuvier coincided in this opinion (142).

Besides Dioscorides and Galen, only one other great name is noticed, namely that of Ptolemæus. I do not bring him forward in this place as a systematic astronomer, or as a geographer, but as the experimental physical philosopher who measured the refraction of light, and was the first founder of an important part of optics. His indubitable rights have been but lately acknowledged (143). However important his progress was in the study of organic life, and in the generalization of his ideas on comparative zoology, yet, in a period which anticipates that of the Arabs by nearly fifty years, we must especially attend to his physical experiments upon the course of rays of light. It is, as it were, the first step in a newly opened path, in the endeavour to advance the study of mixed mathematics.

The distinguished men whom I have just named, and who, in the time of the Roman Emperors, obtained such great fame, were all of Grecian origin; Diophantus (144),

the acute but symbolical writer upon arithmetic and algebra, belonged to a later period. The Greeks, an older and more happily organized and cultivated race, retained their advantage when the stream of civilization was thus divided by the growth of the Roman Empire; the weakened light of knowledge and of scientific investigation disappeared, after the gradual decline of the Alexandrine school in Egypt; it re-appeared, in after-times, in Greece and Asia Minor. As in all unlimited monarchies which include a vast extent of territory and the most heterogeneous elements, so in the Roman Empire the endeavours of the government were principally directed to ward off the threatened dismembering of the entire state, by military force; and by the rivalry of the dissentient members of the administration, they attempted to conceal the disputes in the families of the Emperors by alternate strictness and clemency, and to give the nations, by means of noble rulers, that rest which an absolute but still endurable despotism can periodically afford.

The dominion over the whole world which the Romans attained, resulted from the greatness of their character, and from long-tried strictness of their lives, and an exclusive love of their country, united with a high opinion of their own greatness; but from the inevitable influence of their new relations with other countries, these noble characteristics were gradually weakened, and changed as soon as they had obtained empire of the world. All the public zeal of individuals was extinguished as soon as they lost their national spirit; and these qualities are the two principal supports of a free constitution. The Eternal City had become the centre of too great a circle. They

wanted the spirit capable of enlivening a body so compounded as the empire. Christianity became the state religion, at a time when the kingdom had been already much shaken, and the mildness of the new doctrine was impeded in its beneficial effects by the dogmatical disputes of parties. Then commenced "the troublesome contest between knowledge and faith," which, in various forms, prevents investigation, and which will be continued in all ages.

But although the Roman Empire, which was so completely different from the independent mode of life in the small Grecian republics, failed to enliven and strengthen man's intellectual powers by its vast extent and the consequent form of its constitution, yet, on the other hand, it presented peculiar advantages, which I must here mention. As one result of experience and of a multiplicity of observations, they attained a greater number and richness of ideas. The world of objects was materially enlarged, and in this way prepared for a thoughtful examination of its natural phenomena in after-times. Traffic was kept alive by the Romans, and the Latin language was spread over the whole of the West, and over the northern part of Africa. Greece still lived in the East after the Bactrian kingdom had been destroyed, in the time of Mithridates the First, thirteen years before the invasion of the Sacæ or Scythians.

The Latin language was diffused more extensively, that is, over a much larger surface of the earth, than the Grecian, even before the seat of the empire was transferred to Byzantium. The spread of these two languages, so highly endowed, and so rich in literary memorials, was a

powerful means of promoting union and intercourse between the nations, and of improving their habits and susceptibilities of education, "of making mankind human, as Pliny ([145]) says, and of giving him a common country." Although generally the language of the barbarians (the dumb, ἄγλωσσοι, according to Pollux), was looked upon with contempt; yet there were some instances in Rome, after the example of Lagides, of the translation of a literary work from the Punic into the Latin language. It is well known that the writings of Mago upon agriculture were translated at the command of the senate of Rome.

When the Roman empire had reached to the west of the Old World, at any rate upon the northern coast of the Mediterranean, thus extending to the Promontonium Sacrum, its farthest point, it enlarged its borders eastwards, even in the time of Trajan, who navigated the Tigris, but only as far as the Persian Gulf. In the period of which I am writing, the progress of trade and land traffic, so important for the advance of geographical knowledge, was more considerable in the east than in the west. After the fall of the Grecian Bactrian kingdom, the flourishing power of the Arsacidæ favoured their intercourse with the Seres, but it was through the intervention of other nations, since the actual contact of the Romans with the inhabitants of central Asia had been destroyed by the active carrying trade of the Parthians. The political condition of the enormous territory between the volcanic mountains of Thian-schan and Kuen-lün the northern chain of Tibet, was affected with wonderful rapidity, but not for any length of time, by changes,

which originated in the most distant regions of China. A Chinese army overcame the tribe of Hiungnu, subdued and made tributary to them the small states of Khotan and Kashgar, and carried their victorious arms as far as the eastern coast of the Caspian. That was the great expedition of the General Pantshab, in the time of the Emperor Mingti, of the dynasty of Han. It occurred in the time of Vespasian and Domitian. Chinese authors ascribe grand intentions to this bold and fortunate warrior; they pretend that he would have taken the empire from the Roman (Tathsin), but the Persians dissuaded him from attempting it ([146]). In this way the coast of the Pacific was connected with Shensi and the region of the Oxus, where, in earlier times, active commercial intercourse was carried on with the inhabitants upon the shores of the Euxine.

The direction taken by the vast streams of people in Asia, was from east to west, and in the New World it was from north to south. A century and a half before our era, and about the time of the destruction of Corinth and Carthage, the attack of the Hiungnus (a Turkish race, confounded by Deguignes and Johannes Müller with the Finnish Huns), upon the fair-haired, blue-eyed, and probably Indo-Germanic races ([147]), of the Yueti (Getæ ?) and Usün, near to the Chinese wall, gave the first impulse to migration, which, in about half a century afterwards, reached the borders of Europe. Thus, a wave of people, from the upper valley of the river Hoangho was propagated forwards in a westerly direction to the Don and the Danube; and movements in a contrary direction, in the northern districts of the old continent, brought one part of the human race into contact with another, first of all as

enemies, and afterwards in the friendly relations of trade and commerce. In this way, vast streams of men, advancing like the currents in the ocean, between stationary unmoved masses, have been events of considerable importance in our history of the world.

In the time of the Emperor Claudius, an embassy was sent to Rome, by Rachias from Ceylon, through Egypt. In the time of Marcus Aurelius Antoninus, called "Antun" by the historical writers of the dynasty of Han, Roman ambassadors appeared at the Chinese court. They came by water through Tunquin. I am here pointing out the first traces of the spread of Roman commercial enterprise into China and India, because it is very probable that in the first centuries of our era, by means of the intercourse between these nations, an acquaintance with Grecian astronomy, with their signs of the zodiac and with their astrological method of examining the plants, became more diffused ([148]). The great Indian mathematicians, Warahamira, Brahmagupta, and perhaps even Aryabhatta, are later than the period to which I am here alluding ([149]); but that which was discovered in India, distinctly and in its own way, and at an earlier date, and which originally belongs to its ancient and civilized people, may have partially passed into the west, even before the time of Diophantus, by means of the extensive trade carried on in the time of the Lagides and Cæsars. I cannot here undertake to distinguish the peculiarities of each people and of each epoch; it is sufficient to point out the way by which an interchange of ideas may have taken place.

The great works of Strabo and Ptolemy show us most

clearly the numerous paths by which national intercourse took place, and the advance which it made. The talented geographer of Amasia had neither the practical accuracy of Hipparchus, nor the mathematical ideas of geography found in the works of Ptolemy; but in the number of materials and in the vastness of the plan of his work, it surpasses all the works of antiquity upon the same subject. Strabo remarks, with evident pleasure, that he had seen a considerable portion of the Roman empire with his own eyes, "from Armenia to the Tyrrhenian shores, from the Euxine to the borders of Ethiopia." After he had finished forty-three historical books, in continuation of Polybius, he had the courage to begin the edition of his work upon geography, when he was in his eighty-third year (150). He records his opinion, "that at his time, the dominion of the Romans and Parthians had been more influential in rendering the various parts of the earth accessible, than the campaign of Alexander, as Eratosthenes maintained." The Indian trade was no longer in the hands of the Arabians; Strabo was struck with the increase in the number of ships at Egypt, sailing directly from Myos Hormus to India (151), and his imagination led him far beyond the Indies to the eastern coast of Asia. He represents a connected mountain chain, a continuation of Mount Taurus, running throughout the old continent, along its greatest breadth in the parallel of the Pillars of Hercules and the island of Rhodes, and he guessed at the existence of another continent between the west of Europe and Asia. He says (152), "It is very possible, that in the same temperate zone, and almost in the same latitude as Thinæ (or Athens ?), where it crosses the Atlantic Ocean,

there are inhabited worlds, distinct from that in which we dwell." It is surprising that this expression never attracted the attention of the Spanish authors, who, in the beginning of the sixteenth century, were searching everywhere in classical literature, with the expectation of finding some traces of acquaintance with the New World.

"As in all works of art," Strabo well remarks, "which are intended to represent something grand, it is not requisite especially to attend to the completion of individual portions," so he was willing, in like manner, "in his principal work," to refer particularly to general forms. His inclination to generalize his ideas did not prevent him from recording, at the same time, a vast number of valuable physical results, especially those referring to the study of the earth (153). Like Posidonius and Polybius, he treats of the influence of the rate of the sun's course through the zenith, upon the maximum of temperature in the atmosphere, under the tropics and at the equator; of the various causes of the changes which the earth's surface has undergone; of the outbreak of seas originally surrounded by dry land; of the general level of the sea, known even by Archimedes; of the currents in the ocean; of the eruptions of submarine volcanoes; of the petrefaction of shell-fish and the formation of impressions of fishes; and of the periodical vibrations of the crust of the earth. Strabo says expressly, that the changes in the boundaries of the sea and land are more attributable to the lifting or sinking of the soil, than to any deposit of alluvium; "that not only separate masses of rock, or great or small islands, but that whole continents may be raised up." Strabo, as well as Hero-

dotus, payed attention to the origin of nations and the different races of men, to whom he gives the very remarkable name "of an animal dwelling on land, and requiring much air and light" (154). The ethnological distinctions of the races of mankind are most accurately described in the Commentaries of Julius Cæsar, and in Tacitus' noble panegyric of Agricola.

Strabo's great work, which is so rich in facts, and from whose pages I am here collecting the author's views upon the study of the earth, was almost unknown in ancient Rome down to the fifth century, and was even neglected by Pliny, who was so comprehensive in his own writings. It first had an influence upon the direction of man's ideas at the end of the Middle Ages; but its effect was less than that of Claudius Ptolemæus' work upon geography, which was mathematical and tabular, but containing little account of a physical view of the world. The latter was the guide for all travellers, until the sixteenth century. All discoveries were supposed to be recognized in it under other titles. As natural historians for a long time included all newly discovered plants and animals in the classical catalogue of Linnæus, so the earliest charts of the New World appeared in the Atlas of Ptolemy, published by Agathodæmon, in the time when in the most distant parts of Asia, among the highly cultivated Chinese, the western provinces of their kingdom were represented in twenty-four sub-divisions (155). The Universal Geography of Ptolemy has certainly the advantage of presenting to us the entire Old World, both in a graphic way, that is in sketches, and numerically, that is with the determination of the situation of the places according to the longitude,

latitude, and the length of the day; but although the superiority of astronomical results over deductions from the distances by land or water is frequently expressed, yet, in those inaccurate attempts to determine certain localities, more than two thousand five hundred in number, we cannot recognize upon what principle the calculations are established, or what relative degree of probability may be ascribed to them, according to the itineraries of that age. The Greeks and Romans were completely ignorant of the magnetic needle's pointing towards the north, and never used the compass which had been employed twelve hundred and fifty years before Ptolemy's time in the construction of the *magnetic carriage* of the Emperor Tsingwang; in consequence of this, their most copious itineraries were very inaccurate, from want of certainty in the directions of the places (156), that is in their angle with the meridian.

The more we become acquainted, at the present day, with the Indian and the ancient Persian or Zeno languages, we are so much the more astonished at observing how the greatest part of Ptolemy's geographical nomenclature may be looked upon as an historical memorial of the commercial relations between the west and the most distant regions of southern and central Asia (157). A correct notion of the Caspian Sea, and of the land by which it is completely surrounded, may be looked upon as one of the most important results of their traffic; after five hundred years of error, this notion was again established by Ptolemy, in his geographical work. Herodotus and Aristotle, who fortunately wrote his *Meteorologica* before Alexander's invasion of Asia, knew that the Caspian was thus enclosed.

The Olbiopolitæ, from whence the father of history

obtained his information, were well acquainted with the northern shore of the Caspian between Cuma, the Volga (Rha), and the Jaik (Ural). There was nothing to induce them to imagine that it flowed into the Arctic Ocean. The army of Alexander was deceived by different appearances; they came across Hecatomphylos (Damaghan) down into the damp forests of Mazenderan, and saw the Caspian at Zadracarta, a little to the westward of Asterabad of the present day, stretching out indefinitely towards the north. This view gave the first origin to their supposition, as Plutarch narrates in the life of Alexander, that the sea which they saw before them was a bay of the Euxine ([158]). The expedition of the Macedonians, although, in general, it exerted a beneficial influence in promoting the study of geography, led to individual errors which were retained for a very long time. The Tanaïs was confounded with the Jaxartes, the Araxes of Herodotus; and Caucasus with the Paropanisus, or Hindu-Kho. Ptolemy from his residence in Alexandria could obtain accurate accounts of the countries immediately surrounding the Caspian, as Albania, Atropatene and Hyrcania, and of the caravans of the Aorses, whose camels brought Indian and Babylonian wares to the Don and the Black Sea ([159]). When, in contradiction to the more correct opinion of Herodotus, he expressed his belief that the long axis of the Caspian was directed from east to west, he was probably misled by some obscure intimation respecting the former great extent of the Scythian Gulf (Karabogas), and the existence of the Sea of Aral, the first distinct

account of which is found in Menander [160], a Byzantine author whose work was continued by Agathias.

It is to be regretted, that Ptolemy, who re-established the idea that the Caspian was completely surrounded by land, after the contrary had been for a long time maintained from the prevalence of the hypothesis of the four gulfs, and even by the reflection from the moon [161], did not give up the fable of the unknown southern country, which was supposed to unite the promontory of Prasum with Cattigara and Thinæ, 'Sinarum metropolis,' thus connecting the East of Africa with the land of Tsin, in China. This fable which converted the Indian Ocean into a lake, had its origin in ideas which dated as far back as Marinus of Tyre, to Hipparchus and Seleucus among the Babylonians, and even to Aristotle himself [162]. It will be sufficient in our delineations of the progress made in obtaining general views of the world, if we record certain examples to prove how facts which have once been admitted were frequently forgotten among the fluctuations which occurred in the knowledge of them. When the ancients believed that the extension of their navigation and land traffic had made them acquainted with the form of the whole earth, the active imagination of the Greeks, especially in the Alexandrian age, in the time of the Lagides and the Roman Empire, at once attempted cleverly to connect their old theories with all the new and undoubted discoveries, and prematurely to bring to perfection their map of the world which was scarcely a sketch of the whole.

I have already recorded, in a cursory manner, how

Claudius Ptolemæus from his work upon Optics which the Arabians have imperfectly preserved for us, may be looked upon as the founder of a part of mixed or physical mathematics: a part, which according to Theon of Alexandria (163), was alluded to in the *Catoptrics* of Archimedes, when he referred to the refraction of light. It is a sign of important progress in any study, if physical phenomena are purposely produced(164) under different conditions, and measured, instead of being merely observed and compared with one another; memorable examples of the latter mode are found in Grecian antiquity in the copious problems of Pseudo-Aristotle, and in Roman antiquity, in Seneca's works. Ptolemy's experiments upon the refraction of a ray of light in its passage through media of different density, are characterized by their having been proposed and measured in this way. He conducted rays from the atmosphere into water and glass, and from water into glass at different angles of incidence; and he collected together all the results of his physical experiments, and arranged them in a tabular form. The examination of a physical phenomenon, produced for the express purpose, as for example, of a natural process which is not reduced to the theory of waves of light, is, in the epoch of which we are here treating, an isolated circumstance: Aristotle(165) assumed with respect to light, that it is the movement of a certain medium between the eye and the object. This age presents to our notice also, in the inquiry into the elementary nature of things, a few chemical experiments performed by Dioscorides, and, as I have elsewhere more fully related, the technical art

of collecting fluids(166) driven over in the form of vapour in a genuine apparatus for distillation. Chemistry first began at that time when man was enabled to obtain mineral acids, a most powerful means of dissolving and decomposing matter; and therefore the distillation of sea water, described by Alexander of Aphrodisias in the time of Caracalla, is a matter of great importance. It shows the way in which man gradually arrived at a knowledge of the compound nature of matter, of its chemical constituents and their mutual affinities.

In the Natural History of the organic kingdoms, besides the anatomists, Marinus, and Rufus of Ephesus, who dissected monkeys and distinguished between the nerves of sense and the nerves of motion, and Galen of Pergamus, who rendered obscure everything of which he treated, there are no other names worthy of note. The history of Animals by Ælian of Præneste, and the poem upon Fishes by Oppianus of Cilicia, contain scattered notices, but no facts founded upon their own examination. We can scarcely understand how the innumerable quantity of rare animals (167), which were slaughtered in the Roman amphitheatre for four hundred years, elephants, rhinoceros, hippopotamus, elks, lions, tigers, panthers, crocodiles, and ostriches, were suffered to remain so completely useless for the purposes of comparative anatomy. I have above mentioned the service performed by Dioscorides in promoting the study of botany; he exerted a very powerful and continued influence upon the botanical, pharmaceutical, and chemical knowledge of the Arabs. The botanical garden of the Roman physician, Antonius Castor, made perhaps

in imitation of those of Theophrastus and Mithridates, was probably of no more service in advancing science than the collection of fossil bones made by the Emperor Augustus, in the Museum of Natural Curiosities, which has been supposed, upon very slender grounds, to have been formed by the talented Appuleius of Madaura(168).

In concluding my account of everything which contributed to the advance of general knowledge during the period of the Roman Empire, I must mention the noble undertaking of a "Description of the World," which Caius Plinius the Second attempted to include in thirty-seven books. In the whole of antiquity nothing similar has been attempted; and, although the work during its progress degenerated into a kind of *Cyclopedia of Nature and Art*, yet we cannot deny, that in spite of a certain want of connection between the several parts, the whole work fairly represents a sketch of a physical description of the world: the author in his dedication to Titus is not afraid of applying to his work the Grecian expression ἐγκυκλοπαιδεία, as meaning an abstract and compendium of general knowledge and science.

The 'Historia Naturalis' of Pliny, called, in the catalogue of contents which forms the first book, 'Historia Mundi," and in the letter of his nephew to his friend Macer, by the more applicable term 'Naturæ Historia' includes a description of the Heavens and the Earth; the position and course of the celestial bodies, the meteoric phenomena of the atmosphere, the form of the earth's surface and everything relating to its productions, from the plants and the mollusca of the ocean

up to the human race. All these subjects were treated of and applied, in the most varied way, and brought forth the noblest fruit of creative genius. I speak of the elements of general knowledge, which are scattered about without any arrangement in this great work. "The road over which I am about to travel," says Pliny with noble pride, "has been hitherto untrodden (non trita auctoribus via); no one of our nation, or of the Greeks, has alone undertaken to treat of the entire subject, namely, Nature (nemo apud Græcos qui unus omnia tractaverit). If my enterprise does not succeed, it is, nevertheless, a fine and grand thing to have attempted it (pulchrum atque magnificum)."

A vast picture was suspended before this talented author; but he was disturbed by minute particulars, and not being himself very much accustomed to investigate Nature, he could not grasp the entire picture. His work was not perfectly carried out, and to express an opinion from those parts which are extant at this day, it failed not only on account of the superficial nature of his descriptions, and his occasional ignorance of the subjects under discussion, but from faults in his arrangement. We recognise in the author an active and intelligent man, who rather prided himself upon his vigilance and night-work; but who in his capacity as Governor of Spain, and Overseer of the fleet in lower Italy, was too frequently compelled to trust the loose thread of an endless compilation to his inferiors, often but little qualified by education to perform the duties. This desire for compiling, that is, for laboriously collecting separate observations and facts, as far as the state of knowledge at

the time would permit, is by no means a subject of complaint; the imperfect success of the undertaking depended upon a want of capacity in the author to grasp all the materials that were collected together, to make the description of Nature subordinate to higher and more general views, and to keep clearly in sight a comparative idea of the Creation. The germ of higher notions are found in Eratosthenes and Strabo; they referred, not only to a description of mountains, but to an account of the entire earth: Pliny makes use of the works of the former once only; of the latter not at all. From Aristotle's anatomical History of Animals, Pliny neither extracted the division into great classes founded upon the principal differences in their internal organization, nor did he learn the only true method of reducing the result to general forms, namely, that of induction.

Commencing with pantheistical reflections, Pliny subsequently descends from the contemplation of the heavens to the earth. He recognises the necessity of representing the powers and glory of Nature (naturæ vis atque majestas) as a great harmonious unity, and in the beginning of his third book distinguishes between general and special geography; but this difference is soon neglected when he commences his dry account of the names of countries, mountains, and rivers. The greater part of the work from the 7th to the 27th book and the 33rd, 34th, 36th and 37th books are filled with catalogues of objects from the three natural kingdoms. Pliny the younger, in his letters, characterizes the work of his uncle very correctly "as a learned book, full of matter, and not less manifold in its subjects than Nature herself is (opus diffusum, eruditum, nec minus

varium quam ipsa natura)." There are many things in Pliny which are generally objected to, as being unnecessary and foreign to his subject, which I feel disposed to bring forward and speak of in terms of praise. It appears to me to be particularly gratifying, that he so frequently, and always with so much pleasure alludes to the influence exerted by Nature upon the moral and intellectual development of man. His plan of connecting the subject is seldom well chosen (vii, 24—47; xxv, 2; xxvi, 1; xxxv, 2; xxxvi, 2—4; xxxvii, 1). For example, the account of mineral and vegetable matter leads him to a fragment from the history of sculpture; a fragment which has been of almost more importance for the present condition of our knowledge than anything referring to descriptive natural history which can be extracted from the work.

Pliny's style has more life and spirit than special grandeur; he seldom represents things in an artistic way. We feel that the author has obtained his impressions not so much from Nature herself as from books, although he had opportunities of enjoying her beauties in different climates. A deep and obscure colouring is thrown over the whole. A degree of bitterness is mixed with this sentimental disposition whenever he touches upon the condition of the human race and its destiny; and then, like Cicero([169]), although with less simplicity of diction, a view of the universal grandeur of Nature is represented as strengthening and consoling.

The conclusion of Pliny's 'Historia Naturalis,' the great Roman memorial inherited by the literature of the middle ages, is composed in the genuine spirit of a

descriptive geographical work. It contains, as we have known only since 1831([170]), a view of the comparative natural history of the lands in various zones, the praise of the south of Europe between the two natural boundaries, the Mediterranean and the Alps, and the praise of the southern sky: "where the softness and the temperate air of the climate, as the ancient Pythagoreans also thought, early tended to civilize mankind."

The influence of the Roman Empire, as an element acting continually in uniting nations together, may be represented in the history of a physical examination of the world as most powerful and extensive, because even at a time when the union was more relaxed, or almost destroyed by the stormy incursions of barbarous races, it may be recognised by its distant results. Claudian, who lived in later and troubled times, in the reign of Theodosius the Great and his sons, appears, in the declining period of literature, with renovated powers of poetry, and thus sings of the Roman Empire in almost too laudatory lines([171]);

> "Hæc est, in gremium victos quæ sola recepit,
> Humanumque genus communi nomine fovit,
> Matris, non dominæ, ritu; civesque vocavit
> Quos domuit, nexuque pio longinqua revinxit.
> Hujus pacificis debemus moribus omnes
> Quod veluti patriis regionibus utitur hospes...."

External coercion, or a political constitution rich in resources, or a long habit of slavery may have had the effect of uniting nations together, and of removing existing divisions; but the feeling of communion and unity of the whole human race, and of the equal rights

of all its families, is derived from a more noble source. It is founded upon deeper motives of the mind, and upon religious convictions. Christianity has assisted most powerfully in promoting the idea of the unity of the human race; it has acted beneficially in "rendering man more human" in his manners and institutions. The idea of humanity is interwoven with the earliest Christian doctrines, but it became prevalent by very slow degrees, because, at the time when the new belief was made a state religion at Byzantium from political motives, its supporters were already involved in the miserable contentions of parties, and the distant intercourse of the people was impeded, and the foundations of the kingdom were shaken in many ways, by assaults from other powers. Even the personal freedom of whole classes of men, was for a long time undefended in Christian states, when the ecclesiastics formed corporations, and became possessors of landed property.

These unnatural restraints, and many others which impede man's intellectual progress, and the improvement of his social condition, will gradually disappear. The principle of personal and political freedom is indelibly rooted in his conviction of the equal rights of the whole human race. Mankind appears, as I have elsewhere expressed it(172), "as a vast brotherhood, and as an unit, existing for the purpose of attaining one particular object, namely, the free development of his internal powers." This idea of "humanity," and of the endeavour to advance it, which is at one time impeded and at another makes extensive progress, is by no means the discovery of recent times; it has one universal aim, and therefore

assists materially in elevating and enlivening the world. In the representation of this great historical epoch, namely, the age of the Roman Empire, and of the establishment of Christianity, we must especially bear in mind, that the ideas of man were enlarged, and that an influence acting quietly, continuously and slowly, was exercised upon his intellect and morals at this time.

V. THE INVASION OF THE ARABS—THE INTELLECTUAL CULTURE OF THIS PORTION OF THE SEMITIC RACE—THE INFLUENCE OF A STRANGE ELEMENT UPON THE COURSE OF DEVELOPMENT OF EUROPEAN CIVILIZATION—THE PECULIARITY OF THE NATIONAL CHARACTER OF THE ARABS—THEIR INCLINATION FOR INTERCOURSE WITH NATURE AND HER POWERS—MEDICINE AND CHEMISTRY—THE EXTENSION OF THE SCIENCES OF PHYSICAL GEOGRAPHY, ASTRONOMY AND MATHEMATICS IN THE INTERIOR OF CONTINENTS.

In sketching a history of the physical survey of the earth, that is, in representing the gradual development of *knowledge of an unity in Nature,* I have hitherto reckoned four principal epochs. They are, the attempts to spread from the basin of the Mediterranean eastwards, to the Euxine and Phasis; southwards to Ophir and the tropical gold countries; and westwards through the Pillars of Hercules into the vast ocean "which surrounds all the dry land;" the Macedonian campaign under Alexander the Great; the age of the Lagides and the Roman Empire. We will now examine the mighty influence produced by the Arabians, a strange element

in European civilization, and six or seven centuries afterwards, by the maritime discoveries of the Portuguese and Spaniards, upon the general physical and mathematical natural sciences, the study of the earth and heavenly bodies, their varied size and form, upon the heterogeneousness of matter, and its inherent properties. The discovery and investigation of the New World, with its volcanic chain of the Cordilleras, and its table-lands, where climates are, as it were, arranged one above the other, and its plants spread over a hundred and twenty degrees of latitude, incontestibly indicate the period in which the greatest number of new physical phenomena were in the shortest space of time presented to the notice of man.

After this time the spread of universal knowledge cannot be connected in any way with separate political events, influencing the relations of one country with another. The intellect produces of itself something grand, without being especially excited to it by distinct external occurrences: it works in many directions at the same time, and by new combinations of ideas new instruments are obtained, by which the delicate tissue in the structure of animals and plants, and the distant heavenly bodies may be explored. The entire seventeenth century, brilliantly commenced by the grand discovery of the telescope, and by its earliest fruits, from Galileo's discovery of Jupiter's satellites, the crescent shape of Venus' disc, and the spots upon the sun to Sir Isaac Newton's theory of gravitation, may be considered the most important age in the advance of the newly discovered science, physical astronomy. We thus have, from the similarity

of the object for which men observed the heavens, and made mathematical investigations, a sharply defined division in the vast process of intellectual development, which from this time forward has made uninterrupted and continued progress.

Still nearer to our own times, the indication of particular epochs will be much more difficult, because the activity of man has been directed to many different objects, and because, together with the new arrangement of his social and political relations, a narrower circle of scientific pursuits arose. In those sciences, the development of which we should have to represent in a history of the physical sciences, namely in chemistry and botany, we may point out periods, down to the present time, in which the advance was greatest, or when new ideas became suddenly prevalent; but in the History of the Survey of the World, which, from its very essence, can only borrow from the history of separate sciences, whatever refers to the idea of Kosmos, or an unity in Nature, it will be dangerous and impracticable to point out distinct epochs, because that which we have above called the process of intellectual development presupposes an uninterrupted and parallel advance in all the branches of physical science at the same time. Having arrived at the important point when, after the decline of the Roman Empire a new and strange element of civilization appeared, and when our continent received it for the first time immediately from a tropical country, I thought it would be useful thus far to give a general superficial view of the road, along which we as yet have to travel.

The Arabians, an original Semitic race, partly ex-

pelled the barbarism which numerous public disturbances had spread over Europe during two centuries. They lead us back to the everlasting sources of Grecian philosophy; and not only assist in preserving civilization and science, but they extend them, and lay open the paths of natural inquiries. The commotion in our continent first began, when in the time of Valentinian I., the Huns, a people of Finnish and not Mongolian origin, in the last quarter of the fourth century passed across the Don, and attacked the Alani and afterwards the eastern Goths. Far in the east of Asia a stream of wandering nations was set in motion many centuries before our era. The incursion of the Hiungnus, a Turkish race, gave as I have above remarked the first impulse to this movement; they attacked the fair, blue-eyed race of Usün, probably of Indo-Germanic origin, who bordered upon the Yueti (Getæ?) and lived in the upper valley of the river Hoangho in the north-west of China. This destructive tide of people, propagated from the great wall erected against the Hiungnus, as far as the west of Europe, took a direction through central Asia, north of the Celestial chain of mountains. No religious zeal animated these Asiatic hordes before they arrived at Europe; and it has been distinctly pointed out, that the Mongolians were not even Buddhists (173) at the time when they carried their victorious arms as far as Poland and Silesia. Relations of an altogether different kind gave a peculiar character to the warlike invasion of a southern nation, the Arabians.

The continent of Asia is but little intersected (174), but the peninsula of Arabia is remarkable for its form, as

it stretches out like a separate country, between the Red Sea and the Persian Gulf, and between the Euphrates and the Syrian extremity of the Mediterranean. It is the most westerly of the three peninsulas of southern Asia, and its vicinity to Egypt, and the European shores of the Mediterranean afforded it great advantage both in its political station in the world, and for traffic. In the middle of the peninsula of Arabia dwelt the people of Hedjaz, a noble and powerful race of men, ignorant, but not rude, imaginative, and addicted to the careful observation of all the phenomena of Nature passing around them, in their serene sky, and upon the earth. After this people had lived for thousands of years almost without any intercourse with the rest of the world, leading a Nomad life, they suddenly broke forth, became civilized by contact with the inhabitants of the ancient seats of culture, converted other races, and prevailed from the Pillars of Hercules to the Indus, as far as the point where the mountain chain of Bolor intersects that of Hindu-Kho. From the middle of the ninth century they carried on commercial intercourse simultaneously with the northern countries of Europe, and with Madagascar, with East Africa, India and China; they caused the diffusion of languages, money, and the Indian system of figures, and gave rise to a powerful union of different countries, which lasted for a long time, and was held together by their religious belief. In their marches they passed through great tracts of country. The roving multitudes, when menaced by the natives, encamped according to the expression of their poets, "like groups of clouds, which the wind speedily

scatters." The movements of no other people have shown such active and energetic life; and the spirit and power which are evidently innate in the Mohammedans, appears altogether to have been less lively and effective under the dominion of the Arabs than among the Turkish race. Religious persecution was here as everywhere else (even in Christian lands) rather the effect of an unlimited despotism(175), than of the original doctrines of their belief, or of the religious ideas of the nation. The strictness of the Koran was especially directed against Atheism, and the idolatry of the Aramæic race.

As the life of the people was affected by the varied physical conditions of the soil, by the climate, and by their propinquity to the sea, as well as by their internal ideas, I must here first allude to the varied form of the Arabian peninsula. Although the first impulse to the great changes produced by the Arabs in three continents had its origin from the Ishmaelite race of Hedjaz, and owed its influence principally to a single family of shepherds, yet the rest of the peninsula around its coasts, did not remain for thousands of years cut off from all intercourse with the external world. In exploring the connection and possibility of great and rare events, we must ascend to the causes which gradually prepared the way for them.

Towards the south-west, upon the Erythræan Sea, is the beautiful land of the Joctanidæ(176), Yemen, abounding in fruit and cultivated, the ancient seat of civilization of Sabæi. It produces frankincense (*Lebonah* of the Hebrews, probably the *Boswellia thurifera* of Cole-

brooke ([177]). Myrrh, (a species of Amyris, first accurately described by Ehrenberg), and the so-called balm of Mecca (*Balsamodendron gileadense,* Kunth.); these were objects of an important commercial intercourse with the neighbouring nations, and were exported to the Egyptians, Persians and Indians, as well as to the Greeks and Romans. These productions gave origin to the geographical title of 'Arabia Felix,' which is first found in Diodorus and Strabo. In the south-east of the peninsula, upon the Persian Gulf, Gerrha is situated opposite the Phœnician colonies of Aradus and Tylus, and was an important trading place for Indian wares. Although all the central portion of Arabia may be called a sandy desert without vegetation, yet in Oman, between Jailan and Batna there is a series of well cultivated oases watered by subterranean canals; indeed, the activity of the meritorious traveller Wellsted ([178]) discovered three mountain chains, the highest of which, Jebel Akhdar, is covered with trees, and is six thousand feet above the level of the sea at Maskat. Even in the mountainous country of Yemen, east of Loheia, and in the hills of Hedjaz near the coast in Asyr, as well as east of Mecca, at Tayef, there are highlands, where the temperature is always low, as the geographer Edrisi knew ([179]).

This variety of mountain scenery characterizes the peninsula of Sinai, the copper country of the Egyptians of the old kingdom (before the time of the Hyksus), and the valley of rocks of Petra. I have already mentioned in another part of this book ([180]) the Phœnician settlements in the north of the Red Sea, and the voyages

of Hiram and Solomon to Ophir, which commenced at Ezion-Gaber. Arabia and the neighbouring island of Socotora (the island of Dioscorides) inhabited by Indian colonists, were intermediate trading places between India and the eastern coast of Africa. The productions of these countries were generally confounded with those of Hadhramut and Yemen. "All they (the dromedaries of Midian) from Sheba shall come," as the prophet Isaiah sings, "they shall bring gold and incense (181)." Petra was the trading place for precious wares intended for Tyre and Sidon, and one of the principal settlements of the Nabatæans, who were formerly so important a trading nation, and whose original birthplace is considered by the learned linguist, Quatremère, to have been the mountains of Gerrha upon the lower Euphrates. This northern portion of Arabia, was in continued and active intercourse with other civilized states, chiefly in consequence of its propinquity to Egypt, and the spreading of the Arabian races into the hills bordering upon Syria, Palestine, and the country of the Euphrates, and by means of the famous caravan route from Damascus through Emesa and Tadmor (Palmyra) to Babylon. Mohammed himself was sprung from a noble but impoverished family of the Korishite race, and before he appeared in the character of an inspired prophet and a reformer, he used to visit in his trading journeys, the markets of Bosra on the confines of Syria, of Hadhramut, or the land of frankincense, and principally the market which lasted for twenty days at Okadh, near Mecca, where poets, chiefly Bedouins, annually congregated to compete with their lyrical productions. I have touched upon these particulars in the intercourse of

the Arabians with other nations, and upon the circumstances that gave rise to it, in order to afford a more striking picture of the changes in the world to which it led the way.

The spread of the Arabian nations towards the north brings to our notice two events, the closer relations of which are enveloped in obscurity, but which indicate that thousands of years before Mahommed, the inhabitants of the peninsula had extended to the west and east, towards Egypt and the Euphrates, and had taken a part in the general traffic of other countries.

The Semitic or Aramæic derivation of the Hyksus, which, in the time of the twelfth Dynasty, 2200 years before our era, terminated the Old Kingdom, is now generally allowed by almost all historians. Even Manetho says: "Some writers suppose that these shepherds were Arabians." By other authorities they are called Phœnicians, a name which in ancient times was extended over the valley of the Jordan, and to all Arabian races. The acute author Ewald makes special mention of the Amalekites, who originally lived in Yemen, and afterwards spread through Mecca and Medina to Canaan and Syria, and who were alluded to in Arabic records, as ruling over Egypt in Joseph's time ([182]). It is remarkable, that the Nomad races of the Hyksus should have been able to prevail against the powerful and well organized Old Kingdom of the Egyptians. Men endowed with freedom of spirit appeared with good fortune against those accustomed to long servitude; nevertheless, the victorious Arabian invaders were not then excited by religious animosity as they have been in later times. From dread

of the Assyrians (races of Arphaxad), the Hyksus established the armoury and the fortress of Avaris, upon the eastern mouth of the Nile. This circumstance probably indicates the passage of armies, and a vast migration in a westerly direction. The second event, which occurred about a thousand years later, is one which Ctesias, and after him, Diodorus relates([183]). Ariæus, a powerful Prince of the Himyarites, became an ally of Ninus upon the Tigris, and with him conquered the Babylonians, returning into their own country, the south of Arabia, laden with rich booty([184]).

Although a free shepherd's life prevailed in Hedjaz, and the population was numerous and powerful, yet even there the cities of Medina and Mecca, with Kaaba its ancient mysterious sanctuary, were considered as eminent places resorted to by foreign nations. A perfectly rude and uncivilized condition, the result of complete seclusion, is never found in regions near to the coasts, or to the routes of caravans which are generally formed in the valleys of rivers. Gibbon ([185]), who always so clearly comprehends the varied conditions of mankind, has already recorded the essential difference of the Nomad life in Arabia, from that which Herodotus and Hippocrates describe in the country called the Scythian land; for, in the latter, no part of the shepherd population had settled in towns, whilst in the great peninsula of Arabia, the country people were in constant communication with the inhabitants of the cities, being descendants from the same common origin. In the moors of the Kirgishes, a portion of the places inhabited by the ancient Scythians (the Scoloti and Sacæ) in a country surpassing Ger-

many in extent (186), there has not been for thousands of years a single city; and, nevertheless, at the time of my travels to Siberia, the number of tents (*Yurtes* or *Kibitkes*) in the three wandering hordes were more than 400,000; this brings the number of the Nomad population to more than 2,000,000. It requires no more circumstantial detail to show the influence upon civilization in the contrast between a greater or less degree of seclusion, even supposing that the natural capabilities of two nations are the same.

Among the noble and favoured race of the Arabs, their natural inclination to intellectual improvement, the physical peculiarities of their country and their ancient commercial intercourse along the coast, with highly civilized neighbouring nations, which I have above pointed out, explain how their invasion into Syria and Persia, and afterwards their possession of Egypt, could have so speedily awakened a love for science, and a spirit of inquiry in the victors. It was one of the wonderful arrangements of the order of the world, that the Nestorian sect of Christians, which exerted a very powerful influence in promoting the spread of general knowledge, assisted the Arabs before they came to Alexandria so famed for its learning and controversies; indeed the Nestorians under the protection of the arms of the Mahommedans were enabled to penetrate even to the east of Asia. The Arabs first became acquainted with Grecian literature through the Syrians (187), a Semitic race allied to themselves, and the Syrians, scarcely a century and a half earlier, had received the knowledge of Grecian works from the Nestorians who had been pronounced heretics. Physicians, who had been educated

in the institutions of the Greeks, and in the famous medical school established at Edessa in Mesopotamia by the Nestorian Christians, lived at Mecca at the time of Mahommed in friendly terms with him and with Abu-Bekr.

The school of Edessa, the pattern for the Benedictine schools of Monte-Cassino and Salerno, gave origin to investigations into the natural history of medicinal articles from the vegetable and mineral kingdoms. When they were overthrown by the fanaticism of the Christians in the time of Zeno the Isaurian, the Nestorians spread into Persia, where they soon attained political importance, and established a new medical institution of great repute at Jondisapur in Khusistan. About the middle of the seventh century they succeeded in diffusing their science and their creed as far as China, in the time of the dynasty of Thang, five hundred and seventy-two years after Buddhism had been imported thither from India.

The seeds of eastern civilization, sown in Persia by learned monks and by the philosophers of the last Platonic school of Athens, who were persecuted by Justinian, exercised a beneficial effect upon the Arabs during their first invasion of Asia. However small the amount of knowledge possessed by the Nestorian priests may have been, yet from their peculiar inclination to the study of medicine and pharmacy, they produced an influence upon a race of men who had long lived in the freedom of Nature, and who preserved a more lively sense of every kind of science than the inhabitants of the Grecian and Italian towns. That which gives this epoch of the Arabs so great an importance in the study

of the world, and which must be especially alluded to here, is principally connected with the above mentioned traits in their national character. I repeat, the Arabs must be considered as the chief founders of the Natural Sciences, in the commonly received signification of the term.

It is certainly very difficult to determine the period of the actual commencement of certain ideas, and to trace back the links in the chain which are so intimately connected together. Certain separate and bright points of knowledge may be pointed out as the early processes by which science was attained. How great a distance separates Dioscorides who produced quicksilver from cinnabar, from the Arabian chemist Jeber, or Ptolemæus from Alhazen the optician! The establishment of physical learning and even of the natural sciences, commences at the time when the newly opened paths were trodden by many at the same time, although with unequal results. After the mere inspection and observation of phenomena of the earth and sky casually presented to the eye, comes the investigation and search into what has existed, and the measurement of the magnitude and duration of the occurrence. The earliest epoch of such an inquiry into Nature, which, however, was chiefly confined to the organic kingdoms, was that of Aristotle. A third and higher step in the advancing knowledge of physical phenomena, was the endeavour to explore Nature's powers, to inquire into their mode of acting, and to examine the materials themselves which were set free in order to enter into new combinations. The means which led to this

end are the voluntary production of phenomena, or experiment.

In this last step, which was almost untrodden in antiquity, the Arabs particularly distinguished themselves. They belonged to a land altogether within the delightful region of the palms, and partly within the tropics, for the Tropic of Cancer intersects the peninsula from Muskat to Mecca, and there the heightened vital power in the organs of the vegetable kingdom plentifully produced aromatics and balsams, both beneficial and dangerous articles for man's use. Hence the attention of the people was early directed to the productions of their native soil, and those of the coasts of Malabar, Ceylon and Eastern Africa, which they obtained by commerce. In these portions of the Torrid Zone, individual organic forms are localized in very small regions. Each has its own peculiar productions, and thus man's intercourse with Nature is multiplied by these constant inducements to examine their varieties. They learnt carefully to distinguish these precious articles which were so important for the art of Medicine, for their trade, and for the luxuries of their temples and palaces, and searched for them throughout their country with secrecy and avaricious eagerness. Numerous roads for caravans commencing at the trading place Gerrha upon the Persian Gulf, and at the district of Yemen, so fertile in the production of frankincense, intersected the whole of the interior of the peninsula of Arabia as far as Phœnicia and Syria, and the names of these potent natural products, and an interest for them, were diffused everywhere.

The art of medicine, founded in the Alexandrine school

by Dioscorides, was as a science, originated by the Arabs, who, however, possessed a rich source of instruction in the learning of the Indian physicians, the most ancient of all(188). The chemical art of the apothecary was carried on by the Arabs, and the first writings concerning the preparation of medicines under the direction of the government, which we now call "Dispensatories," had their origin among them. They were afterwards published through the south of Europe by the school of Salernum. Pharmacy and Materia Medica, the first requirements of the healing art, led the way in two directions at the same time, namely to the study of botany and chemistry. From the narrow sphere of usefulness, and partial application to practical purposes, the study of plants gradually spread itself into a wider and freer field; the Arabs explored the structure of the vegetable organic tissues, and examined the connection of the structure with their qualities, and the laws according to which the forms of plants appear in families, and are distributed geographically over the earth, according to varieties in climate and elevation.

After the Asiatic conquests, to retain which, Bagdad became in after times the centre of power and civilization, the Arabs in the short space of seventy years travelled through Egypt, Cyrene and Carthage and all the northern part of Africa, into the most distant points of the Iberian peninsula. The small amount of civilization possessed by the people, and their leaders, might render probable any outbreak of savage wilderness; but the fable of the burning of the Alexandrine library by Amru, and the heating of the four thousand baths for six months by the

books, rests upon the single evidence of two authors who lived five hundred and eighty years after the time when the event is said to have occurred (189). It is scarcely necessary to mention here, that in more peacable times, but before the intellectual development of the entire population had been able to attain any great freedom or elevation, namely in the glittering age of Al-Mansur, Haroun Al-Raschid, Mamun and Motasem, the courts of the princes, and their public scientific institutions were the means of concentrating a large number of the most distinguished men. In these pages it will be useless to lay down the characteristics of the literature of the Arabs which was so diffused, so varied and unequal, nor need we distinguish the productions of the deep and internal organization of the race, and of the natural developments of their dispositions from the result of external impulses and accidental occurrences. The solution of this important question belongs to another sphere of ideas. Our historical considerations are limited to a consecutive enumeration of all the separate additions made by the Arabs, in mathematics, astronomy and the natural sciences, to a general survey of the Creation.

Alchemy, the art of conjuring, and mystic fancies, stripped of all poetic charms by the language of the schools, had even here as through the whole Middle Ages the effect of obscuring the true results of inquiry; but the Arabs worked for themselves indefatigably, and with much labour appropriated the fruits of the culture of former generations by the aid of translations, and thus widened their views of Nature by the addition of much that was original. Writers have already drawn attention to

the great difference ([190]) in respect to civilization existing between the colonies of the Germanic and the Arabian races. The former educated themselves after they had emigrated, the latter brought with them from their native land not only their religion, but also a highly developed language, and the tenderest blossoms of poetry which were not without their influence upon the romances of Provence and the minstrels of the Middle Ages.

The Arabs possessed remarkable attributes to be enabled to appropriate the learning of other races, and to dispense it again, and thus to be of influence from the Euphrates to the Guadalquivir and to the southern part of the middle of Africa. They possessed an unexampled activity, of universal importance in history, and an inclination to separate themselves from the repelling spirit of the castes among the Israelites, and to connect themselves with the vanquished nations, but in spite of their continued change of residence they did not renounce their national character, or their traditional recollections of their original native land. No other nation can point out examples of great land journeys, undertaken by individuals not always on account of trade, but to collect information; even the Buddhist priests from Thibet and China, and Marco Polo and the Christian missionaries, who were sent to the Princes of Mongolia, travelled over but a limited space. By the end of the seventh century ([191]) in the time of the Caliphs of the Ommajedes, the conquests of the Arabs had extended to Cashgar, Cabul and the Punjab, and thus numerous connections with India and China enabled them to bring important parts of Asiatic learning into Europe. The acute investigations of Reinaud have

taught us how much of Indian learning was drawn from Arabian sources. The incursion of the Mongolians into China certainly disturbed their traffic over the Oxus ([192]); but the Mongolians themselves soon became a medium of communication with the Arabs, who by their own inquiries, and by laborious investigations illustrated the study of geography from the shores of the Pacific to the west of Africa, and from the Pyrenees to the moor-lands of the Sherif Edrisi at Wangara in Central Africa. The geography of Ptolemæus was translated into Arabic at Frähn by command of the Caliph Mamun, between the years 813 and 833, and it is not improbable that in the translation some fragments of Marinus Tyrius, which have not otherwise been preserved, might have been added ([193]).

Of the long series of distinguished geographers whose works are preserved to us in the literature of the Arabians, it will be sufficient to name the most famous; namely, El-Istachri ([194]) and Alhassan (Johannes Leo, the African). Before the discoveries of the Portuguese and Spaniards, the study of geography had never been so much enriched at once. Fifty years after the death of their prophet, the Arabs had penetrated to the farthest western coast of Africa, to the haven of Asfi. For a long time it appeared probable to me that the ships of the Arabs visited the islands of the Guanches in later times, when the adventurers known by the title of *Almagurim* navigated the Atlantic (Mare tenebrosum); but more recently doubt has been again thrown upon this subject ([195]). The vast quantities of Arabian coins which are found buried in the countries near the Baltic, and in the extreme north of

Scandinavia cannot be attributed to their own voyages, but to their very extensive inland traffic (196).

The study of geography was not confined to the representation of local relations, to the account of the degrees of latitude and longitude (197), as is seen in the works of Abul-Hassan, and to the description of the countries through which the rivers flow, and of the mountain chains; it rather had the effect of drawing the attention of the people, who were so fond of Nature's beauties, to the organic productions of the soil, especially to the vegetable kingdom. The horror of anatomical investigations which the professors of the Mahommedan religion felt, prevented them from making any progress in the study of Zoology. For their acquaintance with this science, they contented themselves with what they could appropriate from translations of Aristotle (198) and Galen; but still the Zoology of Avicenna, which is in the Royal Library at Paris, is different from that of Aristotle (199). As a botanist, I must name Ibn-Baithar, of Malaga (200), who from his journey into Greece, Persia, India and Egypt, may be looked upon as an example; for he endeavoured, by his own observation, to compare the productions of the different zones of the east and west with each other. The study of medicine was always the starting point for all these attempts; by it the Arabs for a long time governed the Christian schools, and Ibn-Sina (Avicenna) born at Afshena near Bokhara, Ibn-Roshd (Averroes) of Cordova, the younger Serapion from Syria and Mesue from Maradin upon the Euphrates, made use of everything afforded by the caravans and the commerce of the Arabs in order to improve it. I

purposely cite the birth-places of distinguished Arabian philosophers, which are situated far from one another, because they will serve to recal to our minds, in a lively way, that the natural sciences were extended over a vast space from the peculiar intellectual disposition of the race, and that the sphere of knowledge was enlarged by their simultaneous activity.

In this sphere I also include the knowledge possessed by a more anciently civilized nation, the Indians, for in he time of the Caliph Haroun Al-Rashid, many important works, probably those known under the half-fabulous names of Jaraka and Susruta ([201]), were translated from the Sanscrit into Arabic. Avicenna, a man of comprehensive genius, who has frequently been compared to Albert the Great, gives in his 'Materia Medica' a remarkable proof of the influence of Indian literature. He knew, as the learned Royle remarks, the Deodvara Cedar-trees ([202]) of the snow-covered Himalaya Alps, which certainly had not been visited by any Arab in the eleventh century, and he calls them by their real Sanscrit name, considering them to be a lofty species of Juniper, employed in the production of the oil of turpentine. The sons of Averroes lived at the Court of Frederic the Second of the great family of the Hohenstaufens, who owed a part of his acquaintance with the natural history of Indian animals and plants to his intercourse with Arabian philosophers and learned Spanish Jews ([203]). The Caliph Abdurrahman the First, founded a botanical garden at Cordova ([204]), and caused rare seeds to be collected by his own travellers in Syria and other Asiatic countries. He planted the first date tree near his palace at Rissafah, and

celebrated it in a poem which was full of melancholy longing after his native country Damascus.

But the most important influence which the Arabs have exerted generally upon the progress of the natural sciences, was that depending upon their advance in the study of chemistry. A new epoch for this science certainly began with the Arabs; the new platonic fancies of alchemy were related to chemistry in the same way as astrology is with astronomy. The absolute requirements of pharmacy and of the arts led to discoveries which were partly favoured by the intentional experiments of the alchemists and workers in metals, and partly by fortunate accidents. The works of Geber, or rather of Jeber (Abu-Mussah Djafar al-kufi) and the much more recent ones of Razes (Abu-Bekr Arrasi) had the most important results. This epoch is indicated by the discovery and preparation of sulphuric and nitric acids ([205]) of aqua regia, the compounds of quicksilver and of other metallic oxides, and the acquaintance with the process of alcoholic ([206]) fermentation. The first scientific establishment, and advance of chemistry are of value for the history of the survey of the world; at this time they acknowledged the heterogeneous composition of matter and the chemical forces, which are not visible from any motion they produce, but which render of importance the study of the *components,* as well as of the "perfection," of the *form* of matter, noticed in the works of Pythagoras and Plato. The differences in form and composition are the elements of our entire knowledge of matter; they are the abstract principles by which we believe that we can comprehend, by measurement and decomposition at the same time, the structure of the Universe.

It is at present difficult to determine how much of their knowledge the Arabian chemists may have obtained from their acquaintance, with Indian literature (the writings upon the "Rasayana") ([207]), from the original technical works of the Egyptians, from the recent books upon alchemy of Pseudo-Democrites and Synesius the Sophist, or indeed from Chinese sources through the medium of the Mongolians. According to the latest and most careful investigations of a distinguished orientalist, Reinaud, at any rate the discovery of Gunpowder ([208]), and its application to propel hollow projectiles, may not be attributed to the Arabs. Hassan Al-Rammah, who wrote between 1285 and 1295, was unacquainted with this invention, whilst even in the twelfth century, and almost two hundred years before the time of Berthold Schwarz, a kind of gunpowder was employed to blast the rock in the mines of the Rammelsberg in the Hartz forest. The discovery of an air thermometer is also ascribed, in an account of Sanctorius, to Avicenna; this account, however, is very obscure: and six entire centuries elapsed before Galileo, Cornelius Drebbel and the Academy of Cimento, by establishing an accurate mode of measuring heat, produced a splendid means of penetrating into a world of unknown phenomena; namely the natural connection of atmospheric influences, and the means of understanding the phenomena occurring at different depths in the sea, and in the centre of the earth, which had caused so much wonder by their regular periodical occurrence. Among the instances of progress made in physical science by the Arabs, we can only mention Alhaze's work upon refraction, perhaps partially borrowed from the Optics of Ptolemy, and their

acquaintance with the application of the pendulum as a mode of measuring time (209), discovered by the astronomer Ebn-Junis.

Although the purity and continued transparency of the atmosphere in Arabia, caused the people even in their earliest and most uncivilized condition, to pay particular attention to the motions of the heavenly bodies, yet the remarkable scientific activity of the educated Arabs, in every branch of practical astronomy is rather to be ascribed to Chaldean and Indian influence. Besides the worship of the planet Jupiter by the Lachmites, we find that the race of the Asedites, also looked upon the planet Mercury, which is nearer the sun and more rarely seen, as holy. The state of the atmosphere merely aids in the attainment of knowledge, which is elicited among highly gifted races by their genius and natural disposition, and by intercourse with neighbouring educated nations. How many arid regions of tropical America (Cumana, Coro, Payta) have a clearer sky than Egypt, Arabia or Bokhara! The climate in the tropics, and the everlasting charms of the sky glittering with stars and nebulæ everywhere affect the mind; but they only are productive of results, that is they only lead to new ideas, and excite man's intellect to the development of mathematical thoughts, where other internal and external agencies, totally independent of the climate, incline the people to their reception; where, for example, the accurate distribution of the time to comply with the requirements of religion or agriculture, becomes one of the necessities of their social condition. Among calculating trading nations, as the Phœnicians, and among people addicted to building

and to the measurement of the country, as the Chaldeans and Egyptians, empirical rules of arithmetic and geometry were discovered at an early date; but this only prepared the way for the establishment of mathematics and astronomy as sciences. When civilization increased, the regularity and laws of change in the sky, were recognised as being reflected on earthly phenomena, and the latter were explored, according to the expression of our great poet "as far as the steady pole." The conviction of the regularity in the movement of the planets in all climates, principally gave rise to the search after the laws and order of the fluctuation in the atmosphere, of the oscillation of the ocean, of the periodical variation of the magnetic needle, and of the distribution of the organic kingdoms over the surface of the Earth.

The Arabs possessed Indian tables of the planets (210), as early as the end of the eighth century. I have above mentioned that the Susruta, the ancient abstract of all the medical learning of the Indians, was translated by the learned men belonging to the court of the Caliph Haroun Al-Rashid; a proof of the early diffusion of Sanscrit literature. The Arabian mathematician Albyruni went himself to India to study astronomy there. His writings which have but recently been rendered accessible, prove how accurately he was acquainted with the country, the traditions and the comprehensive learning of the Indians (211).

The Arabian astronomers, however, although they owed so much to the more early civilized nations, especially to the schools of India and Alexandria, extended very considerably the range of astronomical knowledge, by their pecu-

liar practical sense, by the vast number and direction of their observations, by the perfection of their instruments for measuring angles, and by the most industrious attempts to improve the ancient astronomical tables, by carefully comparing them with the heavens. In the seventh book of the Almagest of Abul-Wefa, Sédillot recognised the important disturbance of the moon's longitude, which disappears in the conjunction and opposition of the sun and moon, and obtain its maximum when their mutual distance is the eighth of the circle or forty-five degrees, and which, under the name of *Variation*, was for a long time considered to be Tycho's discovery([212]). The observations of Ebn-Junis at Cairo were of great importance in determining the disturbances and eccentricities of the two great planets, Jupiter and Saturn([213]). A measurement of degrees, which the Caliph Al-Mamun directed to be made in the great plains of Sindshar, between Tadmor and Rakka, by observers whose names have been preserved by Ebn-Junis, was less important as regards its results, than from its being a proof of the scientific education of the Arabs.

We must notice the following facts as reflections of this education; in the West, among the Christian Spaniards, the Astronomical Congress at Toledo in the time of Alphonso of Castilia, in which the Rabbin Isaac Ebn Sid Hazan played the principal part; and in the most distant East, the observatories supplied with numerous instruments, where Nassir-Eddin, from Tus in Khorasan, made his observations, and which were erected upon a hill near Meragha, by Ilshan Holagu, the grandson of the renowned warrior Tchingis-Khan. These particulars are de-

serving of mention in a history of a survey of the Creation, because they remind us that the appearance of the Arabs has had an effect over a wide space, in spreading abroad knowledge, in causing the collection of numerical results which in the great epoch of Kepler and Tycho were of considerable assistance in the establishment of theoretical astronomy, and of a correct view of the movements of the heavenly bodies. The light kindled in Asia inhabited by Tartar races, diffused itself in the fifteenth century westward as far as Samarkand, where Ulugh Beig, a descendant of Timur, in addition to an observatory, founded a gymnasium after the pattern of the Museum of Alexandria, and caused a catalogue of the stars to be prepared, which was based upon his own entirely new observations(214).

After having accorded to the Arabs the praise due for their natural science in the two spheres of geography and astronomy, we must also record in this place, their contributions to the treasures of pure mathematics, obtained in the lonely paths of mental efforts. According to the most recent works which have been written upon the history of mathematics in England, France and Germany (215), the algebra of the Arabians is said to have arisen "from two completely independent streams, one originating in India, the other in Greece." The Compendium of Algebra, composed by the Arabian mathematician, Mohammed Ben-Musa (the Chowarezmian), at the command of the Caliph Al-Mamun, was based, as my lately deceased learned friend Friedrich Rosen has pointed out(216), not upon Diophantus, but upon the knowledge of the Indians; indeed, even in the time of Almansor, at the end

of the eighth century, Indian astronomers were invited to the splendid court of Abbassides. According to Casiri and Colebrooke, Diophantus was first translated into Arabic by Abul-Wefa Buzjani, about the end of the tenth century. The progressive proof of the problems, which was wanting in the ancient works of the Indian algebraists, was afforded to the Arabs by the Alexandrine school. The great inheritance was increased by them, and was transferred, in the twelfth century, by Johannes Hispalensis and Gerhard of Cremona, into the European literature of the Middle Ages ([217]). "In the algebraic works of the Indians, we find a general solution of equations of the first degree, and a treatise upon those of the second degree, more completely worked out than in the Alexandrine writings which have come down to us; there is, therefore, no sort of doubt, that if the works of the Indians had been known to Europeans two hundred years ago, and not at the present day for the first time, they must have had considerable influence in advancing the development of modern analysis."

In the same way, and by means of the same relations which gave to the Arabs their acquaintance with the algebra of India, they also obtained their knowledge of the Indian figures; namely, in Persia and upon the Euphrates in the ninth century. Persians were at that time placed upon the Indus, as collectors of the customs; and the use of Indian numbers was generally established in the custom-houses of the Arabs in Northern Africa, opposite the coasts of Sicily. Hence, from the important and well-founded historical inquiries, to which the distinguished mathematician, Chasles was led, by his correct interpretation of the

Pythagorean table in the geometry of Bœthius ([218]), it is more than probable that the Christians in the West were acquainted with the Indian numbers, even earlier than the Arabs, and that, under the title of the system of the counting-board (Abacus), they knew the use of the nine digits, and their value according to their position.

This is not the place to elucidate more fully this circumstance, of which I treated formerly in 1819 and 1829, in two essays, laid before the Academy of Inscriptions at Paris, and the Academy of Sciences at Berlin([219]); but with respect to the historical problem, concerning which much still remains to be discovered, the question is, whether the ingenious and artificial idea of position in reckoning, which appeared in the Tuscan Abacus and in the Suanpan of Central Asia, has been discovered twice; namely, in the East and the West independently; or whether, by the direction of trade in the time of Lagides, it was transplanted from the west of the Indian peninsula to Alexandria, and at the renewal of the hypotheses of the Pythagoreans, was given out as a discovery of the founder of that philosophy. We need not refer to the mere possibility of ancient intercourse between the nations, which is altogether unknown to us, and must have existed before the 60th Olympiad. Why should not the same connection of ideas have separately occurred to highly-gifted people, of different races, from a sense of the same requirements?

Now, although the algebra of the Arabs, in spite of a great scarcity of symbolical signs, had a beneficial influence upon the splendid epoch of the Italian mathematicians of the Middle Ages, through the medium of what they derived

from the Greeks and Indians, yet they deserved the credit of having hastened the employment of the Indian system of figures from Bagdad to Cordova, by their writings and their extensive commercial undertakings. Both agencies, the simultaneous diffusion of science and of the numerical signs with their value according to position, have advanced powerfully, but in different ways, the mathematical part of natural science, and have facilitated the access to the remote regions of astronomy, optics, physical geography, and to the theory of heat and magnetism, which, without their aid, would have remained altogether closed.

In the History of Nations, the question has frequently been asked, what would have been the consequence of events in the world, if Carthage had conquered Rome, and had obtained dominion over the west of Europe? "With equal right might we ask," says William von Humboldt (220), "in what condition would our civilization be at present, if the Arabs, as was the case for a long time, had remained in sole possession of scientific attainments, and had extended themselves throughout the West? It appears to me, that without doubt, the result would have been less favourable in both instances. The influence of the Romans upon our civil institutions, upon our laws, language and civilization, is dependent upon the same causes which gave them dominion over the world, namely their spirit and character, and not upon external or accidental agencies. Under their beneficial influence, and through the close relationship of our races, we became capable of receiving the spirit and language of the Greeks, whilst the Arabs adhered chiefly to the scientific results of Grecian investigation, namely, to natural history, phy-

sical astronomy, and pure mathematics." The Arabs, by carefully preserving the purity of their native dialect, and the acuteness of their figurative language, knew how to give the charms of poetic colouring to the expressions of their feelings and to the noble sentiments of their philosophers; but, to judge from what they were in the time of the Abassides, and from the customs of antiquity with which we find them familiar, they would never have been able to produce the harmonizing works of elevated poetry, and of creative practical genius, of which the flourishing age of our European civilization may boast.

VI.—THE EPOCH OF THE DISCOVERIES IN THE OCEAN —THE DISCOVERY OF THE WESTERN HEMISPHERE— THE INCREASE OF SCIENTIFIC ATTAINMENTS, AND THE OCCURRENCES FOR WHICH IT PREPARED THE WAY— COLUMBUS, SEBASTIAN CABOT AND GAMA—AMERICA AND THE PACIFIC OCEAN — CABRILLO, SEBASTIAN VIZCAINO, MENDANA AND QUIROS—THE RICHEST STORE OF MATERIALS FOR ESTABLISHING A PHYSICAL DESCRIPTION OF THE EARTH IS AFFORDED TO THE INHABITANTS OF THE WEST OF EUROPE.

The fifteenth century is one of those rare epochs, in which all man's endeavours are directed to a definite and common object, and he feels a determined impulse towards one particular goal. The singleness of the effort and the results which crowned it, namely the increased activity of trade among whole classes of nations, give greatness and lasting splendour to the age of Columbus, Sebastian Cabot, and Gama. The fifteenth century is an age of transition between two different stages of civilization, and belongs partly to both: to the Middle Ages, and the commencement of modern time. It is the epoch of the greatest discoveries in respect of space; for the new country included

almost all degrees of latitude and all varieties of elevation upon the surface of the earth. Although it doubled the works of Creation, which were known to the inhabitants of Europe, yet at the same time it afforded to their intellects new and powerful inducements to improve their knowledge of the natural sciences, in the spheres of physics and mathematics ([221]).

Here, as in Alexander's marches, but with still more overwhelming power, the world of objects, including the separate forms of all that is perceptible to the senses and the co-operation of the powers of Nature, forced itself upon man's intellect. The scattered pictures of sensible perceptions, in spite of their number and variety, were gradually united into one concrete whole, comprehending all the phenomena of terrestrial Nature; a result of actual observation and not of the mere hypotheses which float before the imagination in continually changing forms. Even the vault of heaven disclosed to their still unassisted vision, new regions and constellations which they had never seen, and separate moving nebulæ. In no other epoch, as I have already remarked, has a greater number of facts, or a more vast material for the establishment of physical geography been presented to one part of the human race: the sphere of man's vision was more extended, the number of organic productions and commodities for trading increased, and larger colonies were founded than in any previous age. Never have discoveries in the material world caused more extraordinary changes in the habits of a people, from the condition of long slavery in one part of the human race to their subsequent awakening to political freedom.

Anything which shows an important advance in intelligence in some particular epoch in the history of nations, has its origin deeply rooted in the events of the previous centuries. It is not a part of the destiny of the human race to be subject to a gloom which overspreads the whole of mankind at the same time: a principle of conservatism cherishes the everlasting vital process of advancing reason. The age of Columbus fulfilled its destiny with such rapidity only because the fertilizing germs were scattered by a series of highly gifted men, who had lived throughout the dark centuries like a ray of light in the Middle Ages. One single century, the thirteenth, presents to us Sir Roger Bacon, Nicholas Scotus, Albert the Great, and Vincentius of Beauvais. The awakened activity of the intellect bore fruit in the extension of geography. When, in the year 1525, Diego Ribero returned from the Geographical and Astronomical Congress, which was held at the Puente de Caya near to Yelves, to arrange the contested points concerning the boundaries of the two kingdoms, the Portuguese and the Spanish monarchies, an outline of the new continent, from Terra del Fuego as far as the coast of Labrador, had been already drawn. The progress was naturally slower upon the western side, opposite Asia. Rodriguez Cabrillo had penetrated farther to the north than Montery even in the year 1543; and although this great and bold sailor met with his death in the Channel of St. Barbara at New California, yet the pilot of the expedition, Bartholomæus Ferreto, continued it to the forty-third degree of latitude, where Vancouver's Promontory of Oxford is situated. The active emulation of the Spaniards, English and Portuguese, directed to one and the same object, was at

that time so great, that the half of a century was sufficient to determine the external form of the vast extent of country in the western hemisphere, that is, the principal directions of its coasts.

Since the acquaintance of European nations with the western part of the globe is the principal subject to which this section is devoted, and since the numerous relations of a more correct and comprehensive view of the world are arranged around this important event, I must draw a strict line of demarcation between the discovery of the northern parts of America by the Normans which was incontestibly the first, from the subsequent discovery of its tropical regions. Whilst the Caliphs of Bagdad were still flourishing, in the time of the Abbasides and the poetical Samanides bore sway in Persia, America was discovered about the year 1000, by Leif the son of Eric the Red, from the north, as far as the forty-first degree of north latitude ([222]). The first impulse which led to this event arose accidentally in Norway. Naddod in the second half of the ninth century, in an attempt to sail to the Färöe islands, which had been previously visited by the inhabitants of Ireland, was driven by tempests to Iceland. The first Norman settlement, at this place, was made by Ingolf in the year 875. Greenland, the eastern peninsula of a tract of land which appeared to be altogether separated by the ocean from true America, had been seen at an early date ([223]), but was first peopled by colonists from Iceland a century afterwards, in the year 983. The colonization of Iceland, which Naddod first called Snowland (Snjoland), led them, in a south-west direction through Greenland, to the new continent.

The islands of Färöe and Iceland must be considered as intermediate stations, and as the starting places for the enterprise of the discovery of American Scandinavia. In a similar way, their settlement at Carthage enabled the Tyrians to reach the Straits of Gadira and of the haven of Tartessus, and the latter led this enterprizing people from station to station as far as Cerne, the Gauleon (or island of ships) of the Carthaginians ([224]).

Notwithstanding the propinquity of the opposite coasts of Labrador (Helluland it mikla) yet a hundred and twenty years elapsed from the first settlement of the Normans in Iceland, until Leif's great discovery of America; so few were the means which a noble and powerful, but poor race of men were enabled to apply to the advance of navigation in this distant and desert corner of the earth. The coasts of Winland, so called in consequence of the wild vines discovered there by a German, Tyrker, attracted them from the fertility of the soil and the mildness of the climate in comparison with Iceland and Greenland. The country called "the good Winland" (Vinland it goda) by Leif, included the shore between Boston and New York; and therefore parts of the present States of Massachussets, Rhode Island and Connecticut between the parallels of latitude of Civita Vecchia and Terracina, where, however, the average temperature of the year ([225]) is between forty-six and fifty-two degrees (Fahr.). This was the chief settlement of the Normans. The colonists had frequently to contend with the truly warlike race of the Esquimaux, who at that time were spread much further southwards than at present, under the name of the Skrälings. The first Greenland Bishop,

Eric Upsi, a native of Iceland, undertook to go to Winland as a Christian missionary in 1121; and the name of the colonized country is even found in the ancient national songs of the natives of the Färöe islands (226).

The active and bold enterprising spirit of the adventurers of Iceland and Greenland is proved by the circumstance that, after they had settled in the south as far as 41° 30′ north latitude, they erected three pillars to mark out the boundaries near the eastern coast of Baffin's Bay, in the latitude of 72° 55′, upon one of the Women islands (227), north-west of the present most northern Danish colony of Upernavik. The Runic inscription upon the stone, discovered in the autumn of 1824, contains according to Rask and Finn Magnusen, the date of the year 1135. From this eastern coast of Baffin's Bay, the colonists visited with great regularity, on account of the fishery, Lancaster Sound and a part of Barrow Straits, and this occurred more than six centuries before the bold undertakings of Parry and Ross. The locality of the fishery is very accurately described; and Greenland priests, from the diocese of Gardar, conducted the first voyage of discovery in 1266. These north-western summer stations were called the Kroksjardar heathen countries. Mention was early made of the Siberian wood which was there collected, as well as of the numerous whales, seals, walrus and polar bears (228).

Accurate information respecting the former intercourse of the most northern nations of Europe, and the inhabitants of Greenland and Iceland, with the real continent of America reaches only as far as the middle of the four-

teenth century. In the year 1347, a ship was sent from Greenland to Markland (New Scotland) to collect timber and other necessaries. Upon their return from Markland, the ship was overtaken by storms and compelled to land at Straumfjörd in the west of Iceland. This is the last account of the 'Norman America,' preserved for us in the ancient Scandinavian writings (229).

We have hitherto carefully confined ourselves to the regions of history. By means of the critical and most praiseworthy attempts of Christian Rafn, and the Royal Society for Northern Antiquities in Copenhagen, the traditions and ancient accounts of the voyage of the Romans to Helluland (Newfoundland), to Markland, (the mouth of the river St. Lawrence at Nova Scotia), and at Winland (Massachussets), have been separately printed and satisfactorily commented upon (230). The length of the voyage, the direction in which they sailed, the time of the rising and setting of the sun are accurately laid down.

There is less certainty respecting the traces which are supposed to have been found of the earlier discovery of America by the Irish before the year 1000. The Skrälinger, narrated to the Normans, who were settled in Winland, that farther southwards on the other side of Chesapeake Bay, there dwelt "white men who walked about in long white clothes, bearing before them sticks to which white cloths were attached and crying with a loud voice." This account was interpreted by the Christian Normans to signify processions in which they carried flags and sang hymns. In the oldest traditions and in the historical narrative of Thorfinn Karlsefne and the Iceland *Landnama* Book, these

southern coasts between Virginia and Florida are indicated by the name of 'Whiteman's land.' They were in the country itself certainly called 'Great Ireland' (Irland it mikla) and it was supposed that they were peopled by the Irish. According to testimony extending as far back as the year 1064, before Leif discovered Winland, probably about the year 982, Ari Marsson, of the powerful Iceland race of Ulf, on a voyage southwards from Iceland was driven by a storm upon the coasts of the Whiteman's land, and there baptized as a Christian; and not being allowed to go away was subsequently recognized there by people from the Orkneys and Iceland ([231]).

It is the present opinion of some northern antiquarians, that since, in the oldest Iceland documents the first inhabitants of the island were called "western men who had come over the sea," (strangers, who had settled at Papyli on the southern coast, and in the small neighbouring Papar islands,) Iceland was not first peopled immediately from Europe, but from Virginia and Carolina, that is, from Great Ireland, or the American Whiteman's land, by the Irish who had early migrated to America. The important writings of the Irish monk Dicuil, '*de Mensurâ Orbis Terræ*,' which were composed about the year 825, and therefore thirty-eight years before the Normans were acquainted with Iceland through Naddod, do not confirm this opinion.

The investigation of inaccessible regions and the spread of civilization were carried on in the north of Europe by Christian anchorites, and in central Asia by Buddhist monks. The assiduous attempt to diffuse religious doctrines paved the way, at one time, for warlike

undertakings; at another, for the spread of peaceful ideas and commercial intercourse. The zeal which is so peculiar to the religious systems of India, Palestine, and Arabia and which is altogether free from the indifference of Grecian and Roman Polytheism, kept alive the study of geography in the first half of the Middle Ages. Letronne, the commentator of Dicuil has proved in an acute way that after the Irish missionaries were driven out of the Färöe islands by the Normans, they began to visit Iceland about year 795. The Normans when they came to Iceland found there Irish books, bells for ringing for mass, and other objects which former strangers who were called 'Papar' had left behind. These Papæ (fathers) were the Clerici of Dicuil ([232]). Now if, as we must suppose from his testimony, those objects belonged to the Irish monks who came from the Färöe islands, the question is, why are the monks (Papar) called in their native traditions Westmen (Vestmenn) "men who have come from the west over the sea" (komnir til vestan um haf)? Respecting the voyage of the Gallic Prince Madoc, the son of Owen Guineth to a great western country in the year 1170 and the connection of this event with "the Great Ireland" of the Iceland traditions, all accounts are enveloped in deep obscurity. Thus the race of the Celto-Americans gradually disappeared although credulous travellers believe that they are found in many parts of the United States; they have disappeared ever since a strict comparison of languages founded upon grammatical forms and organic structure, and not upon an accidental similarity of sounds has been instituted ([233]).

This first discovery of America in or before the eleventh

century had no great or permanent effect in extending the physical survey of the Creation, such as the second discovery of the same continent by Columbus at the end of the fifteenth century produced; this follows from the uncivilized condition of the people who first went there, and from the nature of the regions to which they were limited. The Scandinavians were prepared by no scientific attainments to explore the country in which they were settled, beyond the immediate satisfaction of their most pressing necessities. The regions of Greenland and Iceland, in which man had to contend with all the difficulties of an inhospitable climate, were looked upon as the countries from which the new colonies were established. The wonderful organization of the republic of Iceland preserved its independence for three centuries and a half, until its political freedom was lost, and the country became subject to the Norwegian King, Hakon VI. The flower of the literature of Iceland, namely, their historical descriptions and their collection of traditions and the Edda poems represent the epoch of the twelfth and thirteenth centuries.

The national treasure of the oldest traditions of Northern Europe, endangered by disturbances in their original country, conveyed to Iceland, and there carefully preserved for future ages, is a remarkable phenomenon in the history of the civilization of nations. This preservation of these sayings, the remote consequence of Ingolf's first settlement in Iceland in the year 875, became an important event with respect to their poetry and imaginative writings, and enabled us to study the obscure fancies of the Scandinavian fables and their allegorical accounts of

the Creation. Natural science alone made no progress. The natives of Iceland in their travels certainly visited the universities in Germany and Italy; but the discoveries of the Greenlanders in the south, and their slight intercourse with Winland, whose vegetation presented to their notice no very remarkable or peculiar physiognomical characters, drew the attention of settlers and seafaring men so little away from their European interests, that no account of the newly colonized countries had been diffused among the civilized natives of the south of Europe. Even in Iceland itself no such account appears to have reached the ears of the famous Genevese sailor. Iceland and Greenland had been at that time separated from one another for upwards of two hundred years, when the latter lost its republican constitution in 1261; all intercourse with foreign countries, and even with Iceland, was formally prohibited as soon as it came into the possession of the Kings of Norway. Christopher Columbus, in his work which has now become so scarce, "upon the five habitable zones of the earth," narrates that he visited Iceland in the month of February 1477, "where at that time the sea was not covered with ice(234), and whither many merchants from Bristol came." If he had there heard of the ancient colonization of a continuous and extensive tract of country opposite their coasts, of "Helluland it mikla," Markland, and the "good Winland," and if he had connected this knowledge of a neighbouring continent with the projects which had occupied him from 1470 to 1473, his journey to Thyle (Iceland) would have been considered of more importance in the famous lawsuit respecting the merit of the first discovery,

which was concluded in 1517; for the suspicious legal officer speaks of a chart (mappamundo) which Martin Alonzo Pinzon had seen at Rome, and upon which the new continent is said to have been delineated. If Columbus had intended to discover a country of which he had obtained information in Iceland, he certainly would not have steered in his first voyage in a direction south-west from the Canaries. Between Bergen and Greenland there was trade communication until 1484, and therefore, seven years after Columbus' journey to Iceland.

The second discovery of the continent of America, namely, of its tropical regions by Christopher Columbus, had a very different influence in extending a Physical Survey of the World, and was followed by different historical results from its first discovery in the eleventh century. Although the sailors who conducted this great expedition at the end of the fifteenth century had by no means the intention of discovering a new quarter of the globe, and although it has been determined that both Columbus and Amerigo Vespucci died in the firm conviction(235) that they had merely reached portions of the east of Asia, yet the expedition had quite the character of the execution of a design formed upon scientific principles. They sailed confidently to the west through the gates which the Tyrians and Colæus of Samos had opened, through "the immeasurable dark sea" (mare tenebrosum) of the Arabian geographers. They aimed at a goal with the distance of which they fancied they were acquainted. The navigators were not accidentally driven thither by tempest, like Naddod and Gardar to Iceland, or like Gunnbjörn, the son of Ulf Kraka, to Greenland; nor were they

conducted in their discovery by means of intermediate stations. Martin of Bohemia, the great natural historian of Nuremberg, who accompanied the Portuguese traveller Diego Cam in his important expeditions to the western coast of Africa, lived four years, namely, from 1486 to 1490, in the Azores; but America was not discovered from these islands, which are situated between the coasts of Spain and Pennsylvania at three fifths of the distance from the latter. The previous design of the work is beautifully celebrated in the poetical stanzas of Tasso. He describes the deeds which Hercules did not dare attempt:

> "He ventured not to tempt the unknown main,
> But limits strict prescribed; in narrow bounds
> The boldness of man's spirit to restrain. . . . . .
> The time shall come when as an idle tale
> The Straits of Hercules shall be—the sail
> Shall dauntless pass their gates, and brave the sea. . . . . .
> A *knight of fair Liguria* first shall dare
> The dangers of this voyage strange to brave. . . . . ."
>
> TASSO, *canto* XV. *stanza* 25, 30 *and* 31.

Notwithstanding this, the great Portuguese historical writer, John Barros([236]), whose first Decade appeared in 1552, could only say concerning this "uom della Liguria" that he was a vain and fanciful babbler, (homem fallador, e glorioso em mostrar suas habilidades, e mais fantastico, e de imaginações com sua Ilha Cypango). In a similar way in all centuries, and in all the various degrees of civilization, national hatred has attempted to obscure the fame of distinguished names.

The discovery of the tropical countries of America by Christopher Columbus, Alonzo de Hojeda and Alvarez

Cabral cannot be looked upon as an isolated occurrence in the history of the Survey of the World. Its influence in the extension of physical science and in enriching the range of man's ideas generally, can only be rightly comprehended by casting a cursory glance at those centuries which separated this epoch of the grand nautical undertakings from the time when scientific attainments flourished among the Arabs. The events which gave to the age of Columbus its peculiar characters, namely, its uninterrupted and successful aim at discoveries in distant regions, and in the extension of the natural history of the earth, were prepared slowly and in many different ways. The path was opened by a few bold men, who made their appearance at an earlier date, and who simultaneously gave rise to a general freedom and independence of thought, and to the investigation of the separate phenomena of Nature; it was rendered accessible by the influence exerted upon the deepest sources of intellectual life by the renewed acquaintance of the Italians with the works of Grecian literature, and the invention of an art which gave wings and endurance to their thoughts; and also by an extended acquaintance with the east of Asia, promoted by the embassies of monks to the Princes of Mongolia, and travelling merchants among the trading nations of the south-west of Europe, among those especially to whom it was an object of their earnest desires to find a nearer way to the spice countries. To all these causes we must add all the means which principally contributed to satisfy their desire, about the end of the fifteenth century, namely, the advance in the art of navigation, the gradual perfection of nautical instruments, the compass and instruments

for examining the stars, and lastly, the application of certain methods for determining the situation of their ships upon a voyage, and the general use of the Ephemerides of the sun and moon according to the system of Regiomontanus.

Without entering into particulars in the history of the sciences, a subject which must be excluded from these pages, we may here mention three great names from the number of those who prepared the way for the age of Columbus and Gama, namely, Albertus Magnus, Roger Bacon, and Vincentius of Beauvais. They are here named in the order of time when they appeared; for the most important, comprehensive, and talented of the three is Roger Bacon, a Franciscan Friar of Ilchester, who was educated in the sciences at Oxford and Paris. All of them anticipated their times, and had a powerful influence upon the period when they flourished. In the long and almost fruitless struggles of dialectic speculations, and of the logical dogmas of a philosophy to which the indeterminate and comprehensive name "scholastic" has been applied, we cannot fail to recognise the beneficial influence, we may almost say, the posthumous effect of the Arab race. The peculiarity of their national character, delineated in the previous section, and their longing for intercourse with Nature, had the effect of diffusing the recently translated works of Aristotle, with which their love of the experimental sciences, and desire to establish them, was most closely connected. Misunderstood doctrines of the Platonic philosophy were prevalent in the schools until the end of the twelfth and the beginning of the thirteenth century. The Fathers of the Church even believed that they discovered in them types of their own religious views. Many

of the symbolical fancies of Timæus respecting physical phenomena were taken up with spirit, and erroneous ideas of the laws of the Creation, again flourished under the authority of the Christians, although the mathematical school of Alexandria had long before pointed out their fallacies. In this way, and under varied forms, the Platonic philosophy, or, to speak more correctly, its echo, was propagated from Augustin to Alcuin, Johannes Scotus, and Bernhard of Chartres, far into the Middle Ages ([238]).

Now when the philosophy of Aristotle had supplanted the doctrines of Plato, it exercised the most decided influence over the efforts of the mind, but in two directions at the same time; in the inquiries of speculative philosophy, and in the philosophical elaboration of empirical knowledge of Nature's laws. The former of these directions, although it appears to be a little foreign to the subject of my work, must not, therefore, be altogether omitted in this place, for, in the middle of the age of scholastic learning, it induced some noble and highly gifted men to think independently in all the various branches of science. A comprehensive physical survey of the earth does not only require a vast number of facts, as the basis for the general ideas; but it requires also a preparatory strengthening of the mind, that in the everlasting contests between science and faith, it may be enabled to repel all fear of the menacing forms which, even until modern times, have appeared at the entrance of certain regions of the experimental sciences, and have attempted to block them up. In describing the course of man's development, the feeling of right to intellectual freedom, and the unsatisfied longing after discoveries in distant regions may not be

separated. There is a series of free and independent thinkers, beginning in the Middle Ages with Dun Scotus, William of Occam, and Nicholas of Cusa, and extending through Ramus, Campanella, and Giordano Bruno, to Descartes ([239]).

The apparently insurmountable "gap between thought and actual existence, and the relations between the mind which discerns, and the objects which are discerned," divided the philosophers into the two distinguished schools of the *Realists* and *Nominalists*. We must here allude to the almost forgotten contest between these schools of the Middle Ages, because it exercised a decided influence upon the final establishment of the experimental sciences. The Nominalists, who only admitted a subjective existence to belong to general ideas in the imagination of man, after many oscillations, ultimately in the fourteenth and fifteenth centuries became the victorious party. From their great aversion to mere abstractions, they first arrived at the necessity of experience, and of increasing the physical basis of knowledge. This direction of their ideas had, at any rate a secondary influence upon empirical natural science; but even whilst the views of the Realists still prevailed, the acquaintance with the Arabian literature had diffused a love for Nature's works, in happy contrast with the study of theology, which otherwise absorbed everything.

Thus we see, that in the different periods of the Middle Ages, to which we have been perhaps accustomed to attribute too great a unity of character, in very different courses, namely in the ideal and the experimental way, the great work of distant discoveries, and the possibility

of their being of avail in the extension of the general ideas of the earth, were gradually advanced.

In the time of the learned Arabians, natural science was closely restricted to medicine and philosophy; in the christian Middle Ages, besides philosophy, dogmatic theological studies were added. The latter, which from their nature aimed at sole sway over the mind, impeded all experimental inquiry into the region of physics, organic morphology and astronomy which is so closely connected with astrology. The study of the comprehensive works of Aristotle transmitted by the Arabian and Jewish Rabbis ([240]), gave rise to a tendency to a philosophical union of all doctrines; Ibn-Sina (Avicenna) and Ibn-Roschd (Averroes), Albert the Great and Roger Bacon will serve to represent the entire human knowledge of their times. The fame, which surrounded their names in the Middle Ages, may be attributed to the vast extension of their religious creed.

Albert the Great, of the family of the Counts of Bollstädt, must be mentioned as an independent observer in the study of analytical chemistry. His hopes were chiefly directed to the change of the metals; but in order to accomplish them, he not only improved the practical manipulation in treating metallic ores, but he increased the insight into the general effects of the natural forces of chemical bodies. His works contained separate and acute observations respecting the organic structure and the physiology of plants. He was acquainted with the sleep of plants, the periodical opening and closing of their blossoms, the decrease in the sap by exhalation from the upper surface of the leaves, and the influence of the

division of the bundles of vessels upon the form of the leaves. He commented upon all the physical works of Aristotle, but upon the history of animals, only from the Latin translation by Michael Scotus from the Arabian version ([241]). A work of Albert the Great, entitled *Liber Cosmographicus de natura locorum,* is a kind of physical geography. I have found in it remarks concerning the dependence of the climate of any place upon the latitude and the elevation at the same time, and upon the effect of the different angles of incidence of the sun's rays upon the temperature of the soil, with which I have been much pleased. That Albert has been celebrated by Dante, is due not so much to himself as to his learned scholar, Saint Thomas Aquinas, whom he brought from Cologne to Paris in 1245 and back to Germany in 1248 :

> " Questi, che m' è a destra più vicino,
> Frate e maestro fummi ; ed esso Alberto
> E' di Cologna, ed io Thomas d' Aquino."
>
> IL PARADISO, X, 97—99.

Albert of Vollstädt's cotemporary, Roger Bacon, was of the greatest importance in the Middle Ages, in extending the natural sciences, and in establishing them by means of mathematics, and the production of phenomena in the way of experiments. Both these men lived in the thirteenth century; but to Roger Bacon credit is due, that the influence which he exercised upon the mode of treatment of natural studies, was more beneficial and of more lasting effect, than the discoveries themselves which have, with more or less justice, been attributed to him. He roused himself to independent thought, and strongly blamed the blind trust in the authority of the schools : yet he was so

far from neglecting to search into Grecian Antiquity that he prizes the study of comparative philology ([242]), the application of mathematics, and the "Scientia Experimentalis," to which he devotes a particular section in his greater work ([243]). One of the Popes, Clement IV., defended and patronized him; but two others, Nicholas II. and IV., accused him of magic, and cast him into prison, and thus he experienced the reverses of fortune which have been felt by great men of all times. He was acquainted with the Optics of Ptolemæus ([244]), and the Almagest. As he always calls Hipparchus 'Abraxis,' like the Arabs, we may conclude that he had only made use of a Latin translation of the Arabic work. Besides Bacon's chemical investigations respecting combustible and explosive mixtures, his theoretical optical works upon Perspective, and the position of the focus in a concave mirror are the most important. His thoughtful work (Opus Majus), contains propositions and plans, the execution of which is possible, but there are no clear traces of successful optical experiments. Depth of mathematical knowledge cannot be ascribed to him. He is principally characterized by a certain activity of imagination which, among the monks of the Middle Ages, was morbidly excited, and in an unbounded degree, towards the study of natural history, by the impression of so many great and unexplained natural phenomena, and by a continued and anxious search after the solution of mysterious problems.

Before the invention of printing, the difficulty of collecting a number of separate manuscripts was much increased by the expense of transcribing, and it produced a great

taste for encyclopediac works in the Middle Ages, when the range of ideas began to be again enlarged after the thirteenth century. This kind of work deserves especial mention here, because it led to the diffusion of general ideas. Among those which appeared at this time were: the twenty books 'De rerum natura' chiefly founded upon one another, and written by Thomas Cantipratensis, professor at Louvain, in 1230; the Mirror of Nature, (Speculum naturale) which Vincentius of Beauvais (Bellovacensis) wrote in 1250 for St. Louis and his wife, Margaret of Provence; the Book of Nature by Conrad of Meygenberg, priest at Ratisbon in 1349; and the Picture of the World (Imago mundi), by Cardinal Peter of Alliaco, Bishop of Cambray in 1410. These Cyclopedias were followed by the 'Margarita philosophica,' the work of Father Reisch; the first edition appeared in 1486, and for half a century had a remarkable influence in the diffusion of knowledge. I must here more especially allude to the 'Picture of the World,' or the Description of the World, by Cardinal Alliacus (Pierre d'Ailly). I have pointed out elsewhere, that the book 'Imago mundi' had more influence upon the discovery of America, than the correspondence with the learned Florentine Toscanelli (245). Everything which Christopher Columbus knew of the Grecian and Roman authors, all the passages of Aristotle, of Strabo and Seneca concerning the propinquity of the eastern coast of Asia to the Pillars of Hercules, which according to his son Don Fernando, principally excited him to undertake the discovery of the Indian countries (autoridad de los escritores para mover al Almirante á descubrir las Indias) the

Admiral obtained from the writings of the Cardinal. He took them with him in his voyages; for in a letter which he wrote in the month of October, 1498, from the island of Haiti to the Spanish Monarch, he translates verbally a passage from the treatise of Alliacus 'de quantitate terræ habitabilis,' which had made the deepest impression upon him. He probably was not aware that Alliacus on his part, had verbally transcribed the part of another earlier work, the 'Opus majus' of Roger Bacon (246). How wonderful an age was that, when a mixture of evidence from Aristotle and Averroes (Avenryz), from Esra and Seneca, concerning the small extent of the sea in comparison with the vast size of the continents of land could convince the King of the security of a costly enterprise!

I have already recorded the fact, that at the end of the thirteenth century a determined longing to investigate Nature's powers, and a continued and philosophical direction in the form of this study, and in its scientific establishment by means of experiments, arose. It still remains for us to delineate, in a few words, the effect which the revival of classical literature after the end of the fourteenth century produced upon the deepest sources of the mental activity of the people, and, in this way, upon a general survey of the earth. The particular efforts of single highly gifted individuals assisted in increasing the stores of the ideal world.

A susceptibility for a freer cultivation of the mind existed at the time when, by means of apparently accidental circumstances, the literature of the Greeks which had been driven back to its ancient seat, obtained a secure

footing in the East. The classical studies of the Arabs had avoided everything belonging to an animated language. They were limited to a small number of the authors of antiquity, and from the special and determined taste of the people for the study of Nature, they preferred the physical books of Aristotle, the Almagest of Ptolemæus, the botany and chemistry of Dioscorides and the fancies of Plato respecting the Creation. Aristotle's 'Dialectics' were united with the study of physics by the Arabs, and, in the earliest portion of the Christian Middle Ages, with Theology. The Arabs borrowed from the Ancients anything which had a special application; but they were far from comprehending completely the spirit of ancient Greece, from entering into the organic structure of the language, from enjoying the poetical creations of the fancy, and from exploring the wonderful richness it possessed in the art of oratory and historical description.

John of Salisbury and Abelard, who had so great an admiration for Plato, had a beneficial influence in diffusing some of the works of classical antiquity, almost two hundred years before Petrarch and Boccaccio. Both of them had a taste for the charms of writings in which freedom and metre, nature and genius, were continually united together; but the influence of the moral feelings excited by them, disappeared without leaving any trace behind. The particular credit of having prepared a lasting settlement in Italy for the fugitive Grecian muses, and of having laboured most powerfully to re-establish classical literature, is due to two most intimate friends, Petrarch and Boccaccio. Barlaam, a monk of Calabria,

who had lived for a long time in Greece, under the patronage of the Emperor Andronicus (247), instructed both of them. They commenced a careful collection of Roman and Grecian manuscripts. Even an historical taste for comparative philology was awakened in Petrarch (248), whose acuteness in the study of languages appeared to aim at a general Survey of the World. Among the most valuable promoters of the study of Grecian literature were, Emanuel Chrysoloras, who was sent in 1391 as Greek Ambassador to England and Italy, the Cardinal Bessarion, from Trapezunt, Gemistus Pletho, and the Athenian, Demetrius Chalcondylas, to whom we owe the first printed edition of Homer (249). All these Grecian emigrations took place before the important taking of Constantinople on the 29th of May, in 1453; but Constantine Lascaris, whose ancestors had occupied the throne there, came to Italy afterwards. The precious collection of Grecian manuscripts which he brought with him is preserved in the library of the Escurial (250), and is but seldom used. The first Greek book was printed only fourteen years before the discovery of America, although the discovery of the art of printing itself was made most probably at the same time, and independently (251) of each other, by Guttenberg at Strasburg and Mayence, and by Lorenzo Janson Koster at Haarlem, between the years 1436 and 1439, and, therefore, in the happy period of the first immigration of learned Greeks into Italy.

Two centuries before all the sources of Grecian literature were discovered in the West, and twenty-five years before the birth of Dante, one of the great epochs in the history of civilization in the south of Europe, events occurred in

Central Asia and in the east of Africa, which, by the extension of commerce, gave rise to the circumnavigation of Africa and the expedition of Columbus. The armies of the Mongolians, in the space of twenty-six years, produced terror throughout Christendom, from Pekin and the Chinese Wall as far as Cracow and Liegnitz. A number of vigorous monks were sent out as missionaries and diplomatists; Johann de Plano Carpini, and Nicholas Ascelin, to Batu Chan, and Ruisbroeck (Rubruquis) to Mangu Chan at Karakorum. The latter of these travelling missionaries made clear and important remarks concerning the geographical distribution of the people, according to their races and languages, in the middle of the thirteenth century. He first of all recognised that the Huns, the Baschkins (inhabitants of Paskatir, Bashgird of Ibn-Fozlan), and the Hungarians, were of Finnish (Ural) origin; and he found Gothic tribes preserving their original language in the strong castles of Krim ([252]). Rubruquis caused both the powerful maritime natives of Italy, the Venetians, and Genoese, to long for the immeasurable wealth of Eastern Asia. Without mentioning the great trading-place, he knew "the silver walls and golden towers" of Quinsay, (Hangtseufu of the present day), which became so famous twenty-five years afterwards through the greatest land-traveller of all ages, Marco Polo ([253]). Truth and simple error are wonderfully mixed up in the account of Rubruquis' travels, preserved by Roger Bacon. Near to Khatai, "bounded by the Eastern Ocean," he describes a happy land, "where strange men and women, who migrate thither, cease to grow old" ([254]). The English knight, John Mandeville, was even more

credulous than the Monk of Brabant, but upon that account his works are much more extensively read. He describes India and China, Ceylon and Sumatra. The comprehensive form as well as the particulars of his descriptions (like the itineraries of Balducci Pegoletti, and the journey of Ruy Gonzalez of Clavijo), have not a little contributed to keep alive an universal commercial intercourse in the world.

It has frequently been supposed, and declared with remarkable decision that the splendid work of the truthful Marco Polo, especially the acquaintance with the Chinese ports and the Indian archipelago which it has diffused, had a great influence upon Columbus, and even that he was in possession of a copy of Marco Polo's work upon his first voyage of discovery (255). I have pointed out that Christopher Columbus, and his son Fernando, certainly mention the Asiatic geography of Æneas Sylvius (Pope Pius II) but never Marco Polo or Mandeville. All that they knew of Quinsay, Zaitun, Mango and Zipangu may have been taken from the distinguished letters of Toscanelli written in 1474 concerning the facility of reaching Eastern Asia from Spain, and from the narratives of Nicolo de' Conti, who travelled through India and the south of China for twenty-five years, without their having any immediate acquaintance with the sixty-eighth and seventy-seventh chapter of the second book of Marco Polo. The most ancient printed edition of his travels was a German translation published in 1477, and this certainly was unintelligible to Columbus and Toscanelli. We certainly cannot deny the possibility (256) of Columbus having seen a manuscript of the Venetian traveller between

the years 1471 and 1492 when he was employing himself with his plans "of searching for the East through the West (buscar el levante por el poniente, pasar á donde nacen las especerias, navegando al occidente);" but why should he not, in his letter of the 7th of June 1503 from Jamaica to the King, in which he describes the coasts of Veragua as a part of the Asiatic *Ciguare* nearer to the Ganges, and hopes to see the horses with golden harness, rather have alluded to the Zepangu of Marco Polo than to that of Pope Pius ?

The diplomatic mission of the monks and their well conducted land journeys, at a time when the dominion of the Mongolians from the Pacific Ocean to the river Wolga, had rendered accessible the central portions of Asia, gave to maritime nations a knowledge of Khatai and Zipangu (China and Japan), and the mission of Pedro de Covilham and Alonso de Payva in 1487, which was set on foot by King John II., in order to search for 'the African Priest Johannes,' paved the way for the voyage of Vasco de Gama, if not for those of Bartholomew Diaz. Believing the accounts which he had obtained from Indian and Arabian pilots in Calicut, Goa, and Aden, as well as in Sofala upon the eastern coast of Africa, Covilham informed King John II., by means of two Jews from Cairo, that if the Portuguese were to continue their voyages of discovery upon the western coast, in a southerly direction, they would come to the end of Africa, whence a voyage to the *Island of the Moon* (Magastar of Polo), to Zanzibar and the gold country of Sofala, would be very easy. But before these accounts reached Lisbon, they already knew there that Bartholomew Diaz not only had

discovered the Cape of Good Hope, (Cabo tormentoso) but that he had sailed round it, although but for a short distance (257). Accounts of the Indian and Arabian trading-stations upon the east coast of Africa, and of the form of the southern extremity of the continent, may have extended to Venice, through Egypt, Abyssinia, and Arabia. The triangular form of Africa was actually delineated upon the map of Sanuto(258), made in 1306, and discovered in the 'Portulano della Mediceo-Laurenziana,' by Count Baldelli in 1351, and also in the chart of the world by Fra Mauro. A history of a Survey of the World includes, without rendering it necessary to mention minute particulars, those epochs in which the principal form of the large continent was first known.

But while their gradually developed acquaintance with the relations of different places induced men to think of methods of shortening their sea-voyages, the means of perfecting their practical navigation rapidly increased, from the application of mathematics and astronomy, and by the discovery of new instruments for measuring distances, and the more skilful use of the powers of the magnet. The application of the magnetic needle's direction towards the north and south, that is, the use of the mariner's compass in Europe, is probably due to the Arabs, and the Arabs again have to thank the Chinese for their knowledge of it. In a Chinese work (in the historical *Szuki* of Szumathsian, a writer in the first half of the second century, before our era) a *magnetic carriage* is mentioned, which the Emperor Tschingwang, of the ancient dynasty of Tscheu, nine hundred years earlier, had presented to the ambassadors

from Tunquin and Cochin China, so that their journey by land, upon their return, might be direct. In the third century of our era, in the dynasty of Han, in the dictionary of Hutschin, *Schuewen* is defined as the mode in which, by the methodical rubbing of a rod of iron, it obtains the property of pointing with one extremity towards the south. On account of the usual direction of their voyages at that time, they always particularly allude to the magnet's pointing southwards. A hundred years later, in the dynasty of Tsin, Chinese ships made use of them in order to sail securely upon the open sea. By means of these ships, a knowledge of the compass spread to India, and thence to the eastern coast of Africa. The Arabic words 'zohron' and 'aphron,' (meaning south and north([259]), which Vincentius of Beauvais in his 'Mirror of Nature' applies to the two ends of the magnetic needle, like the numerous Arabic names of the stars, in use among us at the present day, testify the route through which the West became acquainted with it. In European Christendom the use of the magnetic needle is spoken of as something well known, first in a political and satirical poem entitled 'La Bible,' written by Guyot of Provence in 1190, and in the description of Palestine by Jacob of Vitry, Bishop of Ptolemais, between the years of 1204 and 1215. Also Dante (Paradiso XII. 29) mentions in a simile the needle (ago) "which points southwards."

The discovery of the mariner's compass was for a long time attributed to Flavius Gioja of Positano, not far from the beautiful Amalfi which is so distinguished on account of its naval laws: perhaps he made some

improvements in the apparatus for managing it, in 1302. A much earlier employment of the compass in the European seas, than in the beginning of the fourteenth century, is seen in a naval work by Raymundus Lullus of Majorca, a wonderfully talented and scientific man, whose teaching inspired Giordano Bruno even as a boy([260]), and who was at the same time a systematic philosopher, a chemist, a Christian teacher and navigator. In his book "Fenix de las Maravillas del Orbe," published in the year 1286, Lullus says that the mariners of his times made use of "instruments for measuring, charts of the sea, and the magnetic needle." The early voyages of the Catalonians to the northern coast of tropical Africa (Don Jayme Ferrer arrived in the month of August 1346 at the mouth of the River Ouro), and the discovery of the Azores (Bracir-islands in the map of the world by Picigano in 1367) by the Normans, remind us that long before the time of Columbus they navigated the open Western Ocean. The voyage which under the dominion of the Romans took place in the Indian Ocean between Ocelis and the coast of Malabar, merely in reliance upon the regularity of the direction of the wind([262]), was now performed under the direction of the magnetic needle.

The application of astronomy to navigation was prepared by the influence which was exerted from the thirteenth to the fifteenth century in Italy by Andalone del Nero, and the corrector of Alphonso's chart of the sky, John Bianchini, and in Germany by Nicholas of Cusa ([263]), George von Peuerbach and Regiomontanus. Astrolabes to determine the time and the geographical

latitude by the height of the meridian, and applicable to an element always in motion, were gradually perfected; they obtained them from the astrolabe of he pilots of Majorca, described by Raymund Lullus (264) in the year 1295 in his "Art of Navigation," until Martin of Bohemia completed one at Lisbon in 1484, which, however, was probably only a more simple form of the meteoroscope of his friend Regiomontanus. When the Infant Heinrich, the navigator, Duke of Viseo, established an academy for pilots in Sagres, Maestro Jayme of Majorca was appointed director of it. Martin of Bohemia had the commission from King John II. of Portugal to prepare tables for reckoning the sun's distance and to teach the pilots "to steer by the elevation of the sun and stars." We cannot determine whether at the end of the fifteenth century they were acquainted with the use of the log-line to measure the distances passed over, in addition to the direction which is indicated by the compass: yet it is certain that Pigafetta, Magellan's companion, speaks of the log (la catena a poppa) as of a means for measuring the distance over which they had sailed, as if it had been known for some time (265).

We cannot pass by the influence exerted by Arabian civilization, by the astronomical schools of Cordova, Seville, and Granada, upon the maritime nations of Spain and Portugal. In naval affairs they imitated in a slight degree the great instruments of the schools of Bagdad and Cairo. Even the names were transferred. The name of the astrolabe, which Martin of Bohemia fastened to his main-mast, belonged originally to Hipparchus. When Vasco de Gama landed on the eastern coast of Africa, he

found that the Indian pilots were acquainted with the use of the astrolabe ([266]). In this way, by means of increased communication and general commerce, and by special discoveries and the mutual productions of mathematical and astronomical science, everything was made ready for facilitating the discovery of tropical America, and the speedy determination of its form, for accomplishing the voyage round the southern extremity of Africa to India, and the first voyage round the world, in fact, for all the noble and distinguished performances in the progress of geographical knowledge which took place in thirty years, between 1492 and 1522. The minds of men had also become sharpened, in order to comprehend this boundless store of new phenomena, to work them out, and by comparison, to employ them for the attainment of general and higher views of the Creation.

It will be sufficient in this place to mention the most remarkable of these higher views, which gave men an insight into the connection with the phenomena upon the earth. If we carefully examine the original works of the earliest historians of the Conquista, we are astonished at finding in a Spanish author of the sixteenth century, the germs of so many important physical truths. Upon the occasion of the discovery of a continent, which appeared to be separated from all the other regions of the Creation, in the distant solitude of the ocean, a great number of the same questions with which we are employed at the present day, occurred to the excited curiosity of the travellers, and to those who were collected together by their narratives; these questions were: of the unity of the human race, and the derivation of

its varieties from a common original form: of the migrations of nations and the affinities of languages which frequently manifest great difference in the radical words, as well as in the inflexions and grammatical forms: of the possibility of varieties in the species of plants and animals: of the causes of the trade-winds and of the constant currents in the ocean: of the regular decrease in temperature at the declivities of the Cordilleras, and in the various strata of water at different depths of the ocean: and of the respective effects of chains of volcanic mountains, and their influence upon the frequency of earthquakes, and the extension of the range of the volcanic forces. The foundation of what is at the present day called *physical geography*, is, exclusive of mathematical considerations, found in the works of the Jesuit, Joseph Acosta, *Historia natural y moral de las Indias*, and in the work of Gonzalo Hernandez de Oviedo, which appeared scarcely twenty years after the death of Columbus. In no other period of time since the existence of man, in a social condition, has the range of ideas, in respect to the external world and the relations of different places, been so suddenly and so wonderfully extended, or the necessity of observing natural phenomena in different latitudes and at different elevations above the level of the sea, or of multiplying the means of examining them, so deeply felt.

We might perhaps as I have already remarked in another place ([267]) be induced to suppose that the value of these great discoveries and of the double victory in the physical and intellectual world was first acknowledged in our times since the history of the civilization of the human race has been treated in a philosophical way. Such a

supposition was refuted by Columbus' cotemporaries. The most talented of them anticipated the influence which the events of the latter years of the fifteenth century would exercise upon mankind. "Each day," says Peter Martyr of Anghiera ([268]) in his letters of the years 1493 and 1494 "brings us new wonders from a new world, from the western antipodes, which a certain Genoese traveller, (Christophorus quidam, vir Ligur) has discovered. Although sent out by our monarchs Ferdinand and Isabella, he obtained with difficulty three ships because what he said was considered fabulous. Our friend Pomponius Lætus (one of the most distinguished investigators of classical literature who was persecuted at Rome on account of his religious opinions) could scarcely restrain his tears of joy, when I communicated to him the first accounts of so unexpected an event." Anghiera, from whom we borrow these words, was a talented statesman at the courts of Ferdinand the Catholic and Charles V, formerly ambassador in Egypt and a personal friend of Columbus, Amerigo Vespucci, Sebastian Cabot, and Cortes. His long life included the discovery of the Western Island of the Azores, Corvo, and the expeditions of Diaz, Columbus, Gama, and Magellan. Pope Leo X. read the *Oceanica* of Anghiera aloud to his sister and the Cardinals, "till late in the night." Anghiera says, "I should prefer not to quit Spain again from this time, for here I stand upon the origin of the accounts from newly discovered countries, and as the historian of such great events, may hope to obtain for myself renown among posterity" ([269]). So lively was the feeling among their cotemporaries of the

splendid events, the knowledge of which will live in the minds of future generations.

Columbus, in sailing through the unknown sea westward of the meridian of the Azores, and in applying the recently completed astrolabe for the purpose of determining his locality searched for the east of Asia in a westerly direction, not as an adventure, but upon a confirmed and systematic plan. He certainly had on board his sea-chart which the Florentine physician and astronomer Paolo Toscanelli sent him in 1477 and which fifty-three years after his death was in the possession of Bartholomew de las Casas. According to the manuscript history of the latter, which I examined, this was the "Carta de Marear (270)," which the Admiral showed to Martin Alonzo Pinzon on the twenty-fifth of September 1492, and upon which many distant islands were represented. If, however, Columbus had followed merely the map of his adviser Toscanelli, he would have taken a northern course, and have kept in the parallel of the latitude of Lisbon; he steered, on the contrary, with the hope of reaching Zipangu (Japan) more speedily, for half his voyage in the latitude of the Canary Island Gomera, and afterwards found himself on the seventh of October 1492, in the latitude of twenty-five degrees and a half. Being uneasy at not discovering the coasts of Zipangu, which according to his reckoning he ought to have found two hundred and sixteen leagues more to the eastward, after a long debate, he gave way to the commander of the Caravel Pinta, Martin Alonso Pinzon, whom I have just named, one of the three rich and influential brothers, who were his enemies, and steered in a south-west course.

This alteration in their direction, led to the discovery of Guanahani on the twelfth of October.

We must here rest awhile to consider this wonderful chain of little events, and their manifest influence upon the entire destiny of the world. The meritorious Washington Irving has rightly supposed, that if Columbus in opposition to the counsel of Martin Alonso Pinzon, had continued to sail in a westerly direction, he would have arrived at the warm Gulf Stream, and then would probably have been taken to Florida, and thence perhaps to Cape Hatteras and Virginia; and this is a circumstance of immeasurable importance, since he would then have introduced a Catholic and Spanish population into the present United States of North America, instead of the English and Protestant inhabitants which it afterwards obtained. "The idea," said Pinzon to the Admiral, "that we must sail in a different direction, is to me a kind of inspiration." He also maintained, in the famous law-suit which was carried on against the heirs of Columbus between 1513 and 1515, that on this account the discovery of America was due to him alone. But for the "inspiration," and "that which his heart told him," as in the same trial an old sailor from Moguer said, he had to thank the flight of a flock of pawots, which he had seen in the evening flying in a south-westerly direction, in order as he might have supposed, to rest by night in the trees upon the land. Never has a flight of birds been followed by more important consequences. We may indeed say, that it has determined the first settlements in the New Continent, as well as the original distribution of the Roman and German races of mankind ([271]).

The course of great events, as well as the results of natural phenomena, is fixed by eternal laws, with which we are but very imperfectly acquainted. The fleet which King Emanuel of Portugal, sent in the way discovered by Gama, under the command of Pedro Alvarez Cabral to the East Indies, was unexpectedly driven on the coast of the Brazils on the twenty-second of April in the year 1500. With the zeal which the Portuguese shewed for the circumnavigation of the Cape of Good Hope, ever since the undertaking of Diaz in 1487, they could hardly fail in undergoing a repetition of accidents, similar to that caused by the currents of the ocean upon Cabral's ships. The discovery of Africa would in that case have given rise to the discovery of America, south of the equator. Thus Robertson was enabled to say, that it was part of man's destiny, that the New Continent should be known to the maritime nations of Europe, before the end of the fifteenth century.

Among the peculiarities of the character of Christopher Columbus, we must especially bring forward his searching and acute faculty of insight, by which, without any learned education or acquaintance with physics or natural history, he comprehended and compared the phenomena of the external world. Upon his arrival "to a new world, and under a new sky (272)", he remarked carefully the forms of the tracts of country, the physiognomy of the vegetation, the habits of the animals, the distribution of the temperature and the variations in the terrestrial magnetism. Whilst the old sailor was endeavouring to find the spices of India, and the rhubarb (ruibarba), which had already become so famous through the Arabian

and Jewish physicians and through Rubruquis and the Italian travellers, he also examined closely the roots and fruits and the formation of the leaves of the plants. Whilst we are here recording the influence which this great epoch of maritime discoveries exercised upon the extension of general ideas of the Creation, the representation will become more striking if it is united to the deeds of a single individual. In his journal and the reports of his voyage, which were first published in 1825 and 1829, we shall find that he touches upon almost all the objects, to which the activity of scientific efforts was directed, in the last half of the fifteenth and the whole of the sixteenth centuries.

We need only allude in a general way to the extension of the geography of the Western Hemisphere by means of discoveries, from the time when the Infant Don Heinrich, the sailor, (on his property at Terça upon the beautiful Bay of Sagres) made his first project for discovery, until the time of the South Sea expedition of Gaetano and Cabrillo. The bold undertakings of the Spanish, Portuguese and English prove that, as it were, a new sense for what is vast and boundless was all at once disclosed to them. The advance in nautical skill, and the application of astronomical methods to correct the ship's reckoning, favoured the endeavours which gave its peculiar character to the age, completed the picture of the world and gave rise to universal intercourse among men. The discovery of the mainland of tropical America on the 1st of August, 1498, took place seventeen months after Cabot's voyage to the coast of Labrador in North America. Columbus did not see Terra Firma of South America first

of all in the mountainous region of Paria, as has hitherto been generally supposed, but in the delta of the River Orinoco, east of the Caño Macareo (273). Sebastian Cabot (274) landed on the coast of Labrador between the fifty-sixth and fifty-eighth degrees of latitude on the 24th of June, 1497. I have already shown that this inhospitable region had been visited a half a century earlier by Leif Eriksön, the Iceland traveller.

Columbus assigned more value in his third voyage to the pearls of the islands of Margarita and Cubagua, than to the discovery of Terra Firma; for even to the day of his death he was firmly convinced, that in November in 1492, on his first voyage to Cuba, he had reached a part of the mainland of Asia (275). From this point, if he had had sufficient provisions, (as his son Don Fernando, and his friend the *Cura de los Palacios* narrate) "he would have continued his voyage in a westerly direction, and returned to Spain either by water through Ceylon (Taprobane) "*rodeando toda la tierra de los Negros*" or by land through Jerusalem and Jaffa (276). The Admiral had cherished these plans since 1494, and therefore four years before Vasco de Gama, and anticipated a voyage round the world, twenty-seven years before Magellan and Sebastian de Elcano. The preparations for the second voyage of Cabot, in which he reached as far as the $67\frac{1}{2}^0$ of north latitude, in the midst of the ice, and searched for a passage through to Cathai (China) induced him to meditate "upon a voyage to the North Pole (*á lo del polo arctico*) for later times (277)." The more it became known that the land which was discovered formed a continuous tract of country from Labrador to the Promontory of

Paria, and (according to the famous map of Juan de la Cosa, made in 1500 and but lately known), that it extended upon the other side of the Equator far into the Southern Hemisphere, the desire of finding a passage, either by the north or south, became more intense. Next to the discovery of the mainland of America, and the conviction that the new continent extended southwards from Hudson's Bay to Cape Horn, discovered by Garcia Jofre de Loyasa ([278]), the event of most importance in advancing general views of creation, occurring in the great epoch which we are here representing, was the acquaintance which was attained respecting the South Sea, the ocean by which the western shores of America are bounded.

Ten years before Balboa obtained a view of the South Sea, (on the 25th of September, 1513) from the heights of Sierra de Quarequa upon the Isthmus of Panama, Columbus had expressly said, as he was sailing along the eastern coast of Veragua, that west of this land there was a sea "which in less than nine days' sailing would lead to the *Chersonesus aurea* of Ptolemæus and the mouths of the Ganges." In the same "Carta rarissima" which contains the beautiful and poetical narrative of a dream, the Admiral says that the "opposite coasts of Veragua near the Rio de Belen, is in about the same local relations as Tortosa near to the Mediterranean, and Fuenterrabia in Biscaya as Venice and Pisa." The great ocean (the South Sea) then appeared to them to be but a continuation of the Sinus magnus (μέγας κόλπος) of Ptolemæus, before which the golden Chersonesus was situated, whilst its eastern shore was formed by Cattigara and the land of Sinæ (Thinæ). The fanciful hypothesis

of Hipparchus, according to which this eastern coast of the great gulf was continuous with a portion of the continent of Africa ([279]) extending very far eastwards, and thus the Indian ocean became a confined inland sea, was in the Middle Ages fortunately but little noticed, notwithstanding the great dependence usually placed in the opinions of Ptolemæus; it would otherwise certainly have had a very prejudicial effect upon the direction of their great nautical undertakings.

The discovery and navigation of the South Sea indicate a very important epoch in the knowledge of the relations of the Universe, because by their means scarcely three centuries and a half ago, not only the forms of the western coast of the New World and the eastern coast of the Old Continent have been determined, but also because the numerical comparison of the areas of the dry land and of the water, upon the surface of our planet, is at last beginning to be freed from the most erroneous views, and this a matter of more importance with reference to meteorology. By the size of these areas, and by the relative distribution of dry land and water, the moisture of the atmosphere, the variation in atmospheric pressure, the growth of plants, the more or less extensive diffusion of certain genera of animals, and many other general phenomena and physical processes are materially influenced. The greater extent of surface allowed to the water than to the land, (in the proportion of two and four-fifths to one) certainly lessens the habitable field for the settlements of the human race, and the surface destined to nourish the greater part of the Mammalia, Birds and Reptiles; but according to the laws of presiding over organic life which are at present in force, this relation

between the elements is a condition necessary for preservation, and a beneficial natural arrangement for every thing living upon the continents.

At the end of the fifteenth century there arose an earnest desire to discover the shortest way to the spice countries of Asia; and the idea occurred simultaneously to two talented Italians, of the possibility of reaching the east by a voyage to the westward namely, to the mariner Columbus, and to the physician and astronomer (260) Paul Toscanelli; at this time the opinion, laid down by Ptolemæus in the Almagest, that the Old Continent, from the west coast of the Iberian peninsula to the south of the eastern part of Sinæ, occupied a space of 180 equatorial degrees was generally prevalent; that is, its extent from east to west was considered to be equal to half the circumference of the globe of the earth. Columbus was misled by a series of false conclusions and increased this space to 240^0; the wished-for east coast of Asia, in his opinion, was situated in the meridian of San Diego in New California. He therefore hoped that he should only have to sail 120^0, instead of the 231^0, which is the real distance between the rich Chinese trading city of Quinsay, and the farthest extremity of the peninsula of Spain. In a more remarkable way and in support of his own theories, Toscanelli, in his correspondence with the Admiral, lessened the proportion of the water in the earth. In his opinion, the extent of the sea from Portugal to China was limited to 52^0, so that six-sevenths of the earth is dry land, according to the ancient expression of the prophet Esdras. Columbus, in a letter which he sent to Queen Isabella from Haiti, immediately after

the completion of his third voyage, showed himself to be all the more disposed to this opinion in his later years, because it had been supported by a man who was his highest authority, namely the Cardinal d'Ailly in his *Picture of the World* (Imago Mundi) ([261]).

On the 27th of November, 1520, six years after Balboa, with his sword in hand and wading through the water as high as his knees, believed that he took possession of the South Sea for Castilia, and two years after he lost his head by the hand of the executioner in an insurrection against the tyrannical Pedrarias Davila ([282]), Magellan appeared in the South Sea and sailed through the broad ocean from south-east to north-west in one direction for more than two thousand five hundred geographical miles: before he discovered the Mariana Islands (the *Islas de los Ladrones,* or *las Velas Latinas*) and the Philippines, he had the remarkable lot of seeing no land besides two little uninhabited islands, (the Unhappy Islands, *Desventuradas*), of which one, according to his journal and ship's reckoning, was situated eastward of the Low Islands, the other a little south-west of the Archipelago of Mendaña ([283]). Sebastian de Elcano, after the murder of Magellan upon the Island of Zebu, completed the first voyage round the world in the Victoria, and had for his coat-of-arms, a globe with the famous inscription "*Primus circumdedisti me.*" In September 1522, he entered the harbour of San Lucar, and before an entire year had elapsed, the Emperor Charles, instructed by geographers, in a letter to Hernan Cortez urged upon him the discovery of a route "which would shorten by two thirds the distance to the land of spices."

The expedition of Alvaro de Saavedra was sent from a haven of the province of Zacatula on the western coast of Mexico, to the Moluccas. Hernan Cortez kept up a correspondence in 1527 from the recently taken Mexican chief-town Tenochtitlan "with the Kings of Zebu and Tidor among the Asiatic islands." So rapidly was the spread of a general idea of the world over a vast extent of surface, and with it, an increased vigour in commercial intercourse!

The conquerors of New Spain turned their attention afterwards to discoveries in the South Sea, and from the South Sea to the north-west passage. They could not accustom themselves to the idea, that the mainland extended uninterruptedly from a great distance below the Equator to so high a degree of latitude in the northern hemisphere. When the report of the failure of the expedition of the Cortez spread from the coast of California, the wife of the general, Juana de Zuñiga, the fair daughter of the Count of Aguilar, had two ships fitted out in order to obtain more accurate information.(284) California, before the year 1541, was known to be an arid and desert peninsula, although this was again forgotten in the seventeenth century. From the accounts which we possess from Balboa, Pedrarias Davila and Hernan Cortez, it is especially evident that at that time they hoped to discover, in groups, as in a part of the Indian Ocean, "islands rich in gold, precious stones, spices and pearls." Their excited imaginations led to great undertakings; their boldness and the successful results reacted upon their fancies and inflamed them more powerfully. Thus, in this wonderful time

of the *Conquista* (a time of effort, activity and of a restless anxiety for discoveries both by sea and land) notwithstanding the complete want of political freedom, many things conspired to favour the formation of the character and the education of certain individuals, and to obtain from some highly gifted men, many noble sentiments which only arise from the depths of the soul. It is an error to suppose that the *Conquistadores* were only excited by love of money or by religious fanaticism. Danger always elevates the poetry of life; and the latter was increased, in the mighty epoch which we are here representing in its influence upon the development of general ideas of Creation, by the charm of all their undertakings, and by natural impressions produced by distant voyages, which in our learned age is beginning to be wanting from the continued and manifold discoveries that have been made: it was a charm of novelty, surprize and wonder. Not a hemisphere, but almost two thirds of the globe were at that time a new and uninvestigated world; unseen, like the half of the moon which is turned away from us, and which, according to the laws of gravitation, is always invisible to the eyes of the earth's inhabitants. Our deeper age of inquiry has made more progress in collecting a store of ideas, and obtains a compensation for its want of the surprize which the novelty of great and imposing natural phenomena at one time called forth; a compensation, not indeed for the many, but for the small number of philosophers acquainted with the present state of science. We are allowed a clearer insight into the quiet efforts of Nature's powers; whether it is in electro-magnetism,

or in polarization of light, in the influence of diathermanous substances (bodies permeable to heat), or in the physiological appearances of organic life—a world of wonders, which is disclosing itself to us and at the entrance of which we have scarcely yet arrived!

In the first half of the sixteenth century, the Sandwich Islands, the land of the Papuas and some parts of New Holland were discovered (285). These discoveries prepared the way for those of Cabrillo, Sebastian Vizcaino, Mendaña (286) and Quiros, whose Sagittaria, Tahiti and *Archipelago del Espiritu Santo,* are the New Hebrides of Captain Cook. Quiros was accompanied by the bold mariner who afterwards gave his name to the Straits of Torres. The South Sea then no longer appeared deserted as it did to Magellan; it appeared enlivened by islands, which, however, from want of astronomical observations, seemed to be as it were unfixed and fluctuating here and there in their maps. The South Sea remained also for a long time the sole theatre for the undertakings of the Spanish and Portuguese. The important South Indian and Malay Islands, obscurely described by Ptolemæus, Cosmas and Polo, were disclosed in more definite outlines, after Albuquerque settled himself in Malacca, in 1511, and after the voyage of Anton Abreu. The merit of first knowing so accurately the peculiarities of the physical characters of these islands and their inhabitants, that the Australian Polynesia was separated and considered as the fifth quarter of the globe, belongs principally to the classical Portuguese historian, Barros, a cotemporary of Magellan and Camoens. When the power of Holland first prevailed in the Moluccas, Australia began to appear

from the obscurity which concealed it, and its form became more known to geographical writers (287). Now begins the great age of Abel Tasman. We do not here attempt to represent the history of any particular discoveries in geography; we merely record the principal events, by which, in a short time and in close connection with one another, and in consequence of a suddenly awakened desire for every thing that is vast, unknown and distant, two thirds of the surface of the earth were discovered.

Their extended local acquaintance with the land and sea was equalled by their more complete insight into the existence and laws of Nature's powers, into the distribution of heat over the globe of the earth, into the riches of organized creation and the boundaries of its extension. The advance which the separate sciences had made at the end of the Middle Ages, a period in this respect too little noticed, hastened the comprehension and intellectual comparison of the immeasurable store of physical phenomena, which was all at once presented to their observation. The impressions were deeper and of more effect in establishing a knowledge of the general laws of Nature, because the western European natives had explored the new continent in all its different degrees of latitude before the middle of the sixteenth century, at any rate in the vicinity of the coast, because it was here that they first of all obtained a footing in the proper equatorial region, and because the most pleasing contrasts in the organized forms in the vegetable world and in the climate, were presented to their notice, in a confined circle, among those wonderful elevations of the earth's surface.

As I again find myself compelled to extol the inspiriting superiorities of the mountainous tracts in the equinoctial zone, I must justify my repeated expression of praise by remarking, that the inhabitants of these lands are alone permitted to view all the stars of the sky and all the varied forms of the vegetable kingdom. To see, however, is not to observe; that is, to compare and classify.

If, as I believe I have shown in another work, a taste for accurate observation was in a manifold way developed in Columbus, simply through contact with the grand phenomena of Nature, even when he was altogether without any preliminary knowledge of natural history, yet we may by no means conclude that a similar development of taste took place among the rude and warlike multitudes of the Conquistadores. Europe has gradually and incontestibly obtained, by the discovery of America, an increase in her natural history and in her physical knowledge upon the following subjects: the constitution of the atmosphere, and its effects upon the constitution of man—the variation of the climate at the declivity of the Cordilleras—the height of the line of eternal snow according to measurements in different latitudes of both hemispheres—the arrangement of volcanos—the limits of the range of concussion in earthquakes—the laws of magnetism—the direction of the currents of the ocean, and the gradations of new forms of animals and vegetables: for these she has to thank another and more peaceable class of travellers, a small number of distinguished men among the civil officers in the towns, the ecclesiastics and physicians. They were enabled, during their long sojourn in the old Indian

towns, some of which were situated twelve thousand feet above the level of the sea, to observe with their own eyes, and to confirm and arrange what others had seen, to collect natural specimens, to describe them, and to send them to their friends in Europe. It will be sufficient here to name Gomara, Oviedo, Acosta and Hernandez. Some natural productions (fruits and skins of animals) had been brought home by Columbus from his first voyage of discovery. In a letter of August 1494 from Segovia, the Queen Isabella requests the admiral to continue his collection. She demands of him especially "all sea and land birds which live in other seasons and in another climate." Hitherto but little notice has been taken of the fact that from the same west coast of Africa, from which Hanno nearly two thousand years before brought home with him "the tanned skins of wild women" (the great Gorilla monkey) in order to hang them up in a temple, Cadamosto the friend of Martin of Bohemia collected black elephants' hair, a palm a half in length, for the Infant Heinrich, the sailor. Hernandez, the body physician of Philip II., was sent by him to Mexico in order to have some splendid representations made of all the botanical and zoological curiosities of the country: he might have enriched his series of drawings by copying the numerous and carefully executed pictures of natural history, which, half a century before the arrival of the Spaniards, had been painted at the command of Nezahualcoyotl(288), a King of Tezuco. Hernandez made use of a collection of medical plants, which he found still growing in the famous ancient Mexican gardens of Huaxtepec: on account of a newly

established Spanish hospital(289), which was situated in the neighbourhood, the Conquistadores had not laid them waste. Almost at the same time the fossil bones of Mastodons were discovered in the heights of Mexico, New Granada and Peru, and a description of them was published: this afterwards became of great importance in establishing the theory of the successive elevation of the chains of mountains. The terms "Giants' bones" and "Giants' Plains," *(Campos de Gigantes)*, show how fanciful their first explanations were.

The immediate intercourse of a vast multitude of Europeans, with the free and splendid exotic Nature in the plains and mountainous countries of America, and (after the voyage of Vasco de Gama), in the eastern coasts of Africa and southern India, essentially aided in the diffusion of general views of the Creation, in this excited time. In the beginning of the sixteenth century, a Portuguese physician, Garcia de Orta, established a botanical garden in the present situation of Bombay, under the protection of the noble Martin Alfonso de Sousa, in which he cultivated the medicinal plants of the neighbouring country. The muse of Camoens dealt out to him some patriotic praise. The desire of making personal observations was everywhere awakened, whereas the cosmographical works of the Middle Ages were less the result of the writers' own investigations than mere compilations, which uniformly repeated the opinions expressed in the classical authors of antiquity. Two of the greatest men of the sixteenth century, Conrad Gesner and Andreas Cæsalpinus, gloriously pointed out a new path in zoology and botany.

In order to render more perceptible the early influence exercised by maritime discoveries in enlarging the sphere of knowledge in physical, astronomical, and nautical sciences, I will, in the conclusion of my representation of this epoch, draw the reader's attention to certain bright points which we see glittering in the reports of Columbus. Their first and weaker gleams ought to be noticed with especial care, for they contain the germs of general ideas of the Creation. I omit the proofs of the results which I am here laying down, because I have given them in detail in another work entitled, "*Critical Examination and History of the Development of geographical Acquaintance with the New World, and of Nautical Astronomy in the fifteenth and sixteenth Centuries.*" But to avoid the suspicion of valuing the newer views of physical science less than the observations of Columbus, I will begin, by way of an exception, with the literal translation of a few lines out of a letter written by the Admiral from Haiti in the month of October, 1498. He says in the letter: "Every time that I have sailed from Spain towards India, as soon as I came a hundred leagues to the west of the Azores, I found a remarkable change in the movements of the heavenly bodies, in the temperature of the air, and in the properties of the sea. I have remarked those changes with especial care, and have noticed that the compass (*agujas de marear*), whose declination was hitherto in a north-easterly direction, now passed across to the north-west: and when I had passed over this line (*raya*) as across the brow of a hill (*como quien traspone una cuesta*), I found the sea covered with such a quantity of sea-weed, like little branches of the fir-trees which bear the pistachio nuts,

that we believed that the ships would run aground from want of water. Before we came to the line to which I have just alluded, no trace of this sea-weed was to be noticed. At the boundary line, a hundred leagues to the west of the Azores, the sea became all at once still and calm, scarcely even ruffled by the wind. Upon sailing down from the Canary Islands into the parallel of latitude of Sierra Leone, I had to endure a frightful degree of heat; but as soon as we came across to the other side of the above-mentioned line (*raya*), westward of the meridian of the Azores, the climate changed, the air became more temperate, and its freshness increased the further we advanced."

This passage, which is explained by many others in the works of Columbus, contains ideas of physical geography, remarks concerning the influence of the longitude upon the declination of the magnetic needle, and a notice of the inflection of the Isothermic lines between the west coast of the Old Continent and the eastern coast of America, of the position of the great Sargasso bank in the basin of the Atlantic Ocean, and the relations between this part of the sea and the atmosphere immediately above it. Erroneous observations ([290]) of the movement of the polar star in the vicinity of the Azores Islands, misled Columbus in his first voyage, in consequence of his slight knowledge of mathematics, and induced him to believe in the irregularity of the globular form of the earth. In the Western hemisphere, the earth is, according to him, "more dilated, and the ships gradually approach nearer the heavens, when they come to that line upon the sea (*raya*) where the magnetic needle points towards the true

north; this elevation *(cuesta)* is the cause of the cooler temperature. The festive reception of the Admiral at Barcelona took place in the month of April 1493, and on the fourth of May of the same year, Pope Alexander VI., signed that remarkable bull which fixed the line of demarcation ([291]) between the Spanish and Portuguese possessions "to be for eternity," at a distance of a hundred leagues west of the Azores. If, in addition to this, we considered that Columbus, immediately after his return from his first voyage of discovery, had the intention of going to Rome, in order, as he said, "to report to the Pope everything which he had discovered," and if we think of the value which the cotemporaries of Columbus assigned to the discovery of the point where the needle has no declination, we should consider it a justification of the historical opinion which I first laid down, namely, that the Admiral, at the time when he was in the greatest favour at court, "had attempted to transform a physical boundary line into a political one."

The influence which the discovery of America, and the nautical undertakings connected with it, exercised so rapidly upon the whole of the physical and astronomical sciences, is rendered most perceptible by recording the earliest impressions of cotemporaries, and the vast extent of their scientific attempts, the most important of which were made in the first half of the sixteenth century. Christopher Columbus not only has, incontestibly, the merit of first discovering the line where there is no declination of the needle, but also of first inducing a study of terrestrial magnetism in Europe, by his observations concerning the increasing declination as he sailed in

a westerly direction from that line. It had been already easily recognized in the Mediterranean, and in all places where, in the twelfth century, the declination was as much as eight or ten degrees, even though their instruments were so imperfect, that the ends of a magnetic needle did not point exactly to the geographical north and south. But it is not improbable that the Arabs or Crusaders, who were in communication with the East from 1096 to 1270, at the same time that they diffused the employment of the Chinese and Indian compass, drew attention to the fact of its pointing to the north-east and north-west in different parts of the world, as to a phenomenon which had long been known. We know indeed, certainly, from the Chinese work, Penthsaoyan, which was written in the time of the dynasty of Song (292), between the years 1111 and 1117, that they had at that time long known how to measure the westward variation. The merit which belongs to Columbus, is not for the first observation of the existence of the declination, which is given, for example, upon the map of Andrew Bianco in 1436, but for the remark which he made on the 13th of September, 1492, "that about two degrees and a half to the east of the island of Corvo, the magnetic variation changed and that it passed over from north-east to north-west."

This discovery of a magnetic line without any variation, indicates a remarkable epoch in nautical astronomy. It was celebrated with just praise by Oviedo, Casas and Herrera. If with Livio Sanuto, we ascribe it to the renowned mariner, Sebastian Cabot, we forget that his first voyage, which was undertaken at the expense of some merchants of Bristol, and which was crowned with

success by his first touching the main land in America, falls five years later than the first expedition of Columbus. The latter not only has the merit of having discovered a place in the Atlantic Ocean, where the magnetic meridian at that time coincided with the geographical meridian; but he made at the same time the sensible remark, that the magnetic variation might be of assistance in determining the position of the ship with respect to longitude. In the journal of his second voyage in April 1496, we find the Admiral actually determining his position by observing the needle's variation. The difficulties which chiefly interfered with this method of determining the longitude, in places where the curvatures of the magnetic variation are so considerable, that they do not follow the direction of the meridian but rather, for a great distance, that of the parallels of longitude, were at that time unknown. Magnetic and astronomical methods were earnestly sought for, in order to determine by land and sea the points intersected by the imaginary line of demarcation. Science and the imperfect condition of all their nautical instruments for the measurement of space or time were unequal to the practical solution of so difficult a problem in the year 1493. During the existence of this state of affairs, Pope Alexander VI, had the presumption to divide one half of the globe between two mighty kingdoms, and thus without being aware of it performed essential service to the cause of nautical astronomy, and the physical study of terrestrial magnetism. From that date the maritime nations were oppressed by a vast number of impracticable propositions. Sebastian Cabot, according to the report of his friend

Richard Eden, prided himself even to his last hours, "that by divine providence, an infallible method of finding the geographical longitude had been communicated to him." This was the firm belief upon the regular and rapid variation of the magnetic needle according to the meridians. Alonso de Santa Cruz, a writer upon the physical world, and one of the tutors of the Emperor Charles V, undertook to sketch the first 'Variation Map' (293); this was about the year 1530, and therefore a century and a half before Halley, but it was founded upon very imperfect observations.

Even William Gilbert had no idea of the progression, that is, the movement of the magnetic lines, the knowledge of which is generally ascribed to Gassendi, whilst at an earlier date Acosta, "instructed by Portuguese sailors," assumed the existence of four lines where there is no variation of the needle over the entire globe (294). Scarcely was the dip of the needle discovered in England in 1576 by Robert Norman, when Gilbert boasted, that by means of this instrument he could determine the position of his ship in a dark starless night (*aëre caliginoso*) (295). Immediately after my return to Europe, and by the aid of my own observations in the South Sea, I showed how in certain localities, for example, on the Coast of Peru, in the season of the permanent mist (*garua*), the latitude may be determined by the dip of the needle with a degree of accuracy sufficient for the requirements of navigation. I have here purposely dwelt upon these particulars to point out the original foundation of an important circumstance in the study of the creation, namely, how with the exception of measuring the intensity of the

magnetic force and the hourly changes in the dip, every thing which at present occupies the attention of physical philosophers was alluded to in the sixteenth century. In the remarkable map of America, which was added to the Roman edition of the Geography of Ptolemæus, published in the year 1508, the situation of the magnetic pole is indicated as a mountainous island north of Gruentlant (Greenland), which is represented as part of Asia. Martin Cortez in the *Breve Compendio de la Sphera*, published in 1545, and Livio Sanuto in the *Geographia di Tolomeo*, of the date of 1588, place it more towards the south. The opinion of the latter resembles the prejudice which has even been diffused in more recent times, that "if we were fortunate enough to reach the magnetic pole itself, *(il calamitico)*, we should there witness a wonderful and miraculous phenomenon *(alcun miracoloso stupendo effetto)*."

In the provinces of the distribution of the temperature and of meteorology, the attention of philosophers was directed in the end of the fifteenth and the beginning of the sixteenth centuries, to the decrease in the heat, in proportion as the west longitude increases ([296]) to the curves of the isothermic lines, that is, to the general laws respecting the change of the winds noticed by Lord Bacon of Verulam ([297]), to the decrease of moisture in the atmosphere and of the quantity of rain, caused by the destruction of forests ([298]), to the lower degree of temperature in proportion to the elevation above the level of the sea, and to the lower borders of eternal snow. That this limit of the snow depends upon the geographical latitude, was a fact first recognized by Peter Martyr Anghiera, in 1510.

Alonso de Hojeda and Amerigo Vespucci saw the snow-capped hills of Santa Marta *(tierras nevadas de Citarma)* as early as 1500; Rodrigo Bastidas and Juan de la Cosa examined them more closely in 1501; but it was first from the accounts communicated by the pilot Juan Vespucci, the nephew of Amerigo, to his patron and friend Anghiera concerning the expedition of Colmenares, that the tropical snowy region visible on the mountainous shores of the Caribbean Sea obtained a great, indeed an almost universal, importance. The lower snow limit was now connected with the general relations of the decrease in temperature and the difference of the climate. Herodotus in his inquiries respecting the rising of the river Nile (II. 22) altogether denied the existence of snowy mountains, south of the tropic of Cancer. Alexander's campaign led the Greeks to the Nevados of the Hindu-Kho (ὄρη ἀγάννιφα); but these are situated between the thirty-fourth and thirty-sixth degrees of north latitude. The only mention of "snow in the equatorial zone" which I know as existing before the discovery of America and before the year 1500, is contained in the famous inscription of Adulis, which by Niebuhr is considered to be subsequent to Juba and Augustus: this has been but little noticed by physical philosophers. The acquisition of the knowledge of the fact that the lower snow-limit depends upon the distance of the place (299) from the Pole, the first insight into the law of the perpendicular decrease in the temperature, and the consequent inclination of an upper stratum of the atmosphere of an uniform coolness from the Equator towards the Poles, indicate an epoch of no small importance in the history of our physical science.

But although observations in the suddenly extended sphere of Nature which were accidental, and, as far as their origin was concerned, altogether unscientific, tended to advance physical knowledge; yet the age which I am here delineating was deprived, by the occurrence of untoward circumstances, of another and a purely scientific inducement to study. Leonardo da Vinci, the greatest physical philosopher of the fifteenth century, who united the most wonderful insight into Nature's operations with the most complete acquaintance with mathematics, was a cotemporary of Columbus; he died three years after him. Meteorology occupied the attention of the distinguished artist as well as hydraulics and optics. He rendered his life renowned by his grand paintings and by his spirited conversation, not by means of his writings. If the views of Leonardo da Vinci upon physical subjects had not remained buried in his manuscripts, the field of observation afforded by the New World would have been explored in many branches of science, before the grand epoch of Galileo, Pascal and Huygens. Like Francis Bacon, but a full century before him, he considered *Induction* the only secure method of arriving at conclusions in the natural sciences: "*dobbiamo cominciare dall' esperienza, e per mezzo di questa scoprirne la ragione* (300)."

Now, as the writers who described the first land journeys in these tropical regions frequently made mention of the relations of the climate by alluding to the distribution of the temperature, the extreme dryness of the atmosphere and the frequency of electric explosions; so we find that the mariners had also very correct ideas respecting the course and rapidity of the currents of the

Atlantic, which resemble rivers of very various breadths. The proper equatorial stream, and the motion of the water between the tropics were first described by Columbus. In the account of his third voyage he expressed himself upon this subject in the most precise manner, but still in a general way. "The waters move like the vault of heaven (*con los cielos*) from the East to the West." Even the direction of separate portions of floating seaweed strengthened this belief ([301]). A little pan, made of a light plate of tin, which Columbus found in the hands of the natives of the island of Guadalupe, led him to suppose that it was of European origin, and that it might have been obtained from the wreck of some ship, carried down the equatorial stream from the coast of Spain to America. Among his fancies respecting the physical form of the earth, he imagined that the existence of the southern, as well as the peculiar form of the northern Caribbean islands, that is the correspondence of the direction of their shores with that of the parallels of latitude, was due to the long continued motion of the ocean, between the tropics, from east to west.

When, on his fourth and last voyage, the Admiral became acquainted with the direction of the coast from north to south, from the promontory of Gracias a Dios to the Laguna de Chiriqui, he felt the effects of the powerful streams which run towards the north, and north-north-west, and which result from the impulse of the equatorial current from east to west, against the opposite coast. Anghiera outlived Columbus long enough to comprehend the streams of the waters of the Atlantic, and to learn the existence of the eddy in the Gulf of Mexico, and the

propagation of the movement as far as Newfoundland (*Tierra de los Bacallaos*) and the mouth of the river St. Lawrence. I have elsewhere circumstantially considered how far the expedition of Ponce de Leon, in the year 1512, assisted in determining these points with accuracy, and I have stated, that in a treatise of Sir Humphrey Gilbert, written between the years 1567 and 1576, entitled *The motion of the waters of the Atlantic ocean, from the Cape of Good Hope to the Bank of Newfoundland*, the subject is viewed in a light almost completely in accordance with the opinions of my excellent departed friend, Major Rennell.

At the time when the currents of the sea were first known, they became also acquainted with the vast banks of sea-weed *(fucus natans)* "the meadows of the ocean," which present the wonderful spectacle of a collection of plants covering a space nearly seven times as large as France. The great Bank of Sea-weed, the proper *Mar de Sargasso*, spreads out between the nineteenth and thirty-fourth degrees of north latitude. Its chief axis lies about seven degrees to the westward of the island of Corvo. The Smaller Bank, on the other hand, lies between the Bermudas and Bahamas. The winds and partial currents in different years slightly affect the position and the extent of these Atlantic "sea-weed meadows," the first description of which is due to Columbus. No other sea, in either hemisphere, displays a similar extent of surface covered by plants collected in this way ([302]).

The important epoch of these discoveries and the sudden disclosure of an unknown hemisphere, also increased

man's ideas respecting the heavenly bodies, or, as I should more properly express myself, respecting the visible vault of heaven. They saw, in their wanderings into distant regions (under different degrees of latitude), "the land and the stars," as Garcilaso de la Vega expresses it, change together (303), and thus their arrival at the Equator, on both coasts of Africa, and at the southern extremity of the New Continent presented to the sailors and land travellers the splendid spectacle of the stars of a southern sky, for a longer time together and more frequently, than could have happened in the time of Hiram and the Ptolemeans, in the time of the Roman empire and the Arabian traffic, in the Red Sea or in the Indian Ocean between the Straits of Babel-Mandeb and the western coast of the peninsula of India. In the letters of Amerigo Vespucci, in the works of Vincente Yañez Pinzon and Pigafetta, the companion of Magellan and Elcano, and also in Andreas Corsali's description of his voyage to Cochin in the East Indies, we find in the beginning of the sixteenth century, the first and most spirited representations of the southern sky, beyond the foot of the Centaur and the splendid constellation of the ship Argos. Amerigo, who had more literary learning, but was also more vain-glorious than the others, praises in an animated description, the brightness, the artistic grouping and the strange appearance of the few stars which surround the south pole. In his letter to Pierfrancesco de Medici, he intimates that, in his third voyage, he has carefully employed himself in the study of the southern constellations, and had measured and marked

down the distance of the principal stars from the pole. His contributions upon this subject enable us to bear patiently the loss of his measurements.

The mysterious black spots (Kohlensäcke, *Coalbags*) were first described by Anghiera, in the year 1510. They had been already noticed in 1499, by the companions of Vincente Yañez Pinzon in the expedition which started from Palos, and took possession of the Brazilian coast, Cap San Augustin (304). The *Canopus niger* (Canopo fosco) of Amerigo, is probably one of the coalbags. The acute observer, Acosta, compares them with the shaded portion of the moon's disc, and appears to attribute them to a vacant space in the sky, that is, to an absence of stars. Rigaud has shown that a distinguished astronomer considered the "Coalbags" to be the first intimation of a knowledge of the spots on the sun, although Acosta expressly says that they are visible in Peru, but not in Europe, and that they move round the south pole like other stars (305). An acquaintance with the two Magellanic clouds has been falsely ascribed to Pigafetta. I find that Anghiera, upon the strength of some observations of Portuguese sailors, mentions these clouds as early as eight years before the end of Magellan's voyage round the world. He compares their feeble light with that of the Milky Way. The sharp-sighted Arabs appear also to have discovered the greater cloud. It is very probably 'the White Ox,' *el Bakar*, of their southern sky, that is, 'the white spots,' of which the astronomer Abdurrahman Sofi says, that they are not visible in Bagdad, nor in Northern Arabia, but that they can be seen in Tehama, and in the parallel of latitude of the Straits of

Babel-Mandeb. Greeks and Romans wandered in the same direction in the time of the Lagides and afterwards; but they did not remark, or, at any rate, did not notice in any of their writings which have come down to us, the cloud of light, which nevertheless in the eleventh or twelfth degree of north latitude rose, in the time of Ptolemæus, three degrees, and in the time of Abdurrahman, in the year 1000, more than four degrees above the horizon (306). The meridian height of the middle of the "Nubecula Major," at the present day, probably reaches as high as five degrees, in the latitude of Aden. If navigators generally first discovered the Magellanic clouds in much more southern latitudes, near the Equator, or even still further southward, the fact depended upon the properties of the atmosphere, and the reflection of the white light from the mists or the horizon. In southern Arabia, and in the interior of the country, the dark blue colour of the sky, and the great dryness of the atmosphere, enabled them more easily to recognize these clouds. Examples, where the tails of comets have been visible in broad daylight, between the tropics, and in very southern latitudes, are a proof of this statement.

The classification of the stars composing the new constellations in the neighbourhood of the Antarctic Pole, belongs to the seventeenth century. The observations made with the aid of very imperfect instruments by the Dutch sailors, Petrus Theodori von Emden and Friedrich Houtmann, who was a prisoner of the king of Bantam and Atschin, in Java and Sumatra, from 1596 to 1599, were registered in the map of the heavens by Hondius, Bleaw (Jansonius Cæsius) and Bayer.

The unequal and irregular distribution of the light gives to the crowded nebulæ and clusters of stars in the rich zone of the southern hemisphere, between the parallels of fifty and eighty degrees, a peculiar and almost picturesque character, and a charm which arises from the grouping of the stars of the first and second magnitudes, and their separation by spaces which appear quite dark and empty to the naked eye. These wonderful contrasts, the milky way lighted up with varied degrees of brightness in different parts of its extent, the separate and rounded forms of the revolving Magellanic light-clouds, and the "Coalbags," the larger of which is so near to a splendid constellation, increase the variety of this picture of nature; they attract the attention of a susceptible observer to particular regions in the farthest portions of the southern hemisphere. One of these regions has been of importance since the beginning of the sixteenth century by the special reference, which was partly of a religious character, of the Christian mariners in the tropical and southern seas, as well as of Christian missionaries in both Indies: this is the region of the *Southern Cross*. The four principal stars which form it were reckoned in the Almagest as well as in the epochs of Adrian and Antoninus Pius, as forming the hind feet of the constellation of the Centaur(307). It is a little surprising, as the form of the cross is so pleasing and has something so distinct and so peculiar about it, as in the constellation of the greater and lesser Bear, in Scorpion, Cassiopeia, the Eagle and the Dolphin, that those four stars were not earlier separated from the vast and ancient constellation of the Centaur; and it

is so much the more so, when we consider that the Persian Kazwini and other Mahommedan astronomers made out crosses of their own from the Dolphin and Dragon with considerable difficulty. Whether the courtly flattery of the Alexandrine philosophers, who changed Canopus into "Ptolemæum," also called the stars of the present Southern Cross for the sake of honouring Augustus, by the name of "the Throne of Cæsar, invisible in Italy," is a matter of considerable doubt(308). At the time of Claudius Ptolemæus, the beautiful star at the foot of the Southern Cross, in passing through the Meridian, attained at Alexandria the altitude of 6° 10′, whilst at the present day it is concealed many degrees under the horizon. In order to see the star *a Crucis* in 6° 10′ of elevation at the present day, (1847), allowing for the refraction of the light, we must go ten degrees south of Alexandria to 21° 43′ of north latitude. The Christian settlers at Thebais might have seen the Cross in the fourth century at an elevation of ten degrees. I think nevertheless that the name did not originate from them; for Dante in the famous passage of the Purgatorio says:

"Then turning to the right, I cast my eyes
To the other pole, and lo! four stars appeared,
Ne'er seen but at the first in Paradise...."

and Amerigo Vespucci, who first mentioned this passage in his third voyage whilst describing the view of the starry sky of the southern hemisphere, and boasted "that he had himself seen the four stars which had only been seen by the first of mankind," did not know the name

of "the Southern Cross." Amerigo says, quite simply, that the four stars form a rhomboidal figure, (*una mandorla*), and this remark was made in the year 1501. In proportion as the sea voyages, upon the route first discovered by Magellan and Gama round the Cape of Good Hope and through the southern ocean, became more numerous, and Christian missionaries spread into the newly-discovered tropical country of America, the fame of this constellation increased. I find it first mentioned as a wonderful Cross, (*Croce maravigliosa*), "more splendid than all the constellations of the whole sky," in the works of the Florentine astronomer, Andrea Corsali, in 1517, and afterwards by Pigafetta, in 1520. The well-read Florentine writer praises Dante's prophetic spirit; as if the great poet had not possessed as much erudition as imaginative power, and as if he had never seen Arabian celestial globes, or had intercourse with numerous oriental travellers in Pisa([309]). Acosta, in his History of India (*Historia natural y moral de las Indias*) ([310]), remarks that in the Spanish colonies in tropical America, the first settlers, like those of the present day also, made use of the different degree of inclination, or the perpendicular position of the Southern Cross as an instrument in the heavens for calculating the time.

By the comparison of one night with another, as time advances, the view of the starry sky changes in every point of the earth. The ancient races of mankind saw the splendid southern constellations rise even in their most northern latitudes, and these, after being for a long time invisible, will reappear after thousands of years. In the time of Columbus, Canopus was, at

Toledo, in the latitude of 39° 54′, full 1° 20′ under the horizon; it is at the present day about as far above the horizon at Cadiz. In Berlin, and the northern latitudes generally, the stars of the Southern Cross, and α and β of Centaur are becoming more and more distant, whilst the Magellanic Clouds are gradually approaching our latitudes. Canopus has been at its nearest point of northern approximation during the last thousand years, and now is going more southwards, but very slowly, because of its propinquity to the south pole of the ecliptic. The Cross began to be invisible in the degree of 52½° of north latitude about 2900 years before our era, where, according to Galle, it had been previously seen to attain even more than ten degrees of altitude. When it disappeared from the horizon of our Baltic shores, the great pyramid of Cheops had already existed in Egypt for half a century. The pastoral tribes of the Hyksus made it fall seven hundred years later. These remote and past ages appear to approach nearer to us when we connect them with some memorable events.

Progress in nautical astronomy, that is, in the perfection of the methods for determining the situation of a ship at sea, as to its geographical latitude and longitude, was simultaneous with the extension of a more intelligible and scientific arrangement of the heavenly bodies. All the following means, which in the course of time tended to advance the art of navigation, may be considered as having been of great service in disclosing to the notice of man the entire globe, in forwarding commercial intercourse, and in establishing comparative views of the Creation; they

were, the use of the compass and the attainment of precision with regard to the dip of the needle; the measurement of speed by means of the careful contrivance of the log — the use of the chronometer and the calculation of the moon's distances — the better construction of vessels — the employment of another power instead of that of the wind—and, above all, the skilful application of astronomy in keeping the ship's reckoning. In establishing this position, I must again record, that even in the middle of the thirteenth century in the navy of the Catalanians and the island of Majorca, "nautical instruments were in use, in order to find out the time by the height of the stars," and that the astrolabe described by Raymundus Lullus in his work upon navigation, (*Arte de navegar*), is almost two hundred years older than that of Martin of Bohemia. The importance of astronomical methods was so completely admitted in Portugal, that about the year 1484 Martin was named President of a mathematical commission (*Junta de Mathematicos*) to calculate and make tables of the sun's declension; and as Barros(311) says, to teach the pilots to steer by the sun's altitude (*maneira de navegar per altura do sol*). This plan of navigating, "according to the meridian height of the sun," was at that time definitively separated from the plan of sailing by the elevations from east to west (*por la altura del Este-Oeste*) (312), that is, by determining the longitude.

As I have already remarked, the necessity of finding out the position of the line of demarcation laid down by the Pope, and the boundaries between the rightful possessions of the Spanish and Portuguese monarchs

in the newly-discovered Brazils and southern Indian islands, materially increased the desire to discover practical means of determining the longitude. People found by experience how seldom the imperfect method of Hipparchus depending upon eclipses of the moon, was applicable; and the use of the moon's distances was recommended in 1514 by Johann Werner, an astronomer of Nuremberg, and soon afterwards by Orontius Finæus and Gemma Frisius. This method, however, necessarily remained for a long time useless, until after many vain attempts with the instruments of Peter Apianus, (Bienewitz), and Alonzo de Santa Cruz, the reflecting sextant was discovered in the year 1700 by Newton's genius, and was diffused among sailors in 1731.

The influence of the Arabian astronomers upon the progress of the science of navigation was also extended from Spain. Many unsuccessful attempts were made to discover a mode of determining the longitude; and the blame of the want of success was less frequently referred to their imperfect observations than to typographical errors in the astronomical ephemerides of Regiomontanus, of which they made use. The Portuguese, indeed, suspected the results of the Spanish astronomical calculations, thinking that they had falsified their tables from political motives([313]). The necessity of methods, which suddenly arose and which were promised, at least theoretically, by the study of nautical astronomy, is expressed in an animated way in the reports of Columbus' voyages, in those of Amerigo Vespucci, Pigafetta and Andres de San Martin, the famous pilot of Magellan's expedition, who possessed Ruy Falero's

method of determining the longitude. The oppositions of the planets, occultations of the stars, differences in elevation between the moon and Jupiter, and changes in the moon's declinations, were all attempted with more or less success. We possess observations on astronomical conjunctions made by Columbus in Haiti in the night of the 13th of January, 1493. The necessity of adding a proper and well-educated astronomer to every great expedition was so generally felt, that the Queen Isabella wrote to Columbus on the 5th of September, 1493, to the following effect: "Although he had proved by his undertakings that he knew more than any other mortal, (*que ninguno de los nacidos*), yet she advised to take with him Fray Antonio de Marchena, as being a learned and suitable astronomer." Columbus says, in the description of his fourth voyage: "There is only one perfectly sure method of keeping a ship's reckoning, namely, that of the astronomers. A man who understands astronomy may be content: the information it affords resembles a prophecy (*vision profetica*) ([314]). Our ignorant pilots, when they have been out of sight of the coast for a few days, do not know where they are. They would never find those countries again which I discovered. The compass and the science of astronomy (*Compas y arte*) are necessary for navigation."

I have specially mentioned these particular characteristics because they make it more clear how nautical astronomy, the powerful means of rendering navigation secure, and thus of facilitating access to all regions of the world, received its first development in the epoch which I am here delineating; and how, in the general

stir among men of genius, they became acquainted with the possibility of means, which could come into extended practical application, as soon as clocks and instruments for the measurement of angles were constructed, and tables of the position of the sun and moon drawn up. The character of a century is "the manifestation of the human intellect in a definite period," and the age of Columbus and of the great maritime discoveries, multiplied, in an unexpected manner, the objects of knowledge and of man's contemplation, and gave a new and higher impulse to after-centuries. It is peculiar to important discoveries that they extend the circle of what is known, whilst at the same time they open farther the prospect of what still remains to be overcome. Weak minds have a self-complacent belief with respect to every age, that mankind has arrived at the highest pinnacle of intellectual progress; they forget that, from the intimate union of all natural phenomena, in proportion as we advance, the field through which we still have to pass increases in extent, and that it is bounded by an horizon which incessantly becomes more distant from the inquirer.

Where can the history of nations point out an epoch like that in which the following important occurrences were crowded together; namely, the discovery and first colonization of America,—the voyage to the East Indies round the Cape of Good Hope—Magellan's first voyage round the world—the most vigorous condition of the arts—the attainment of intellectual and religious freedom, and the sudden extension of acquaintance with geography and astronomy? At the distance of time in

which we see it, such an epoch is indebted for a very small portion of its greatness, to the circumstance that it appears in the records of history alone to be unclouded by the disturbing realities of the present. As in all earthly matters, the splendour of fortune has been here also closely connected with deep misery. The progress of general ideas of the creation was bought with all the violence and abominations which the so-called civilized conquerors diffuse over the globe. It is an incredible and presumptuous degree of boldness to dogmatise respecting the distribution of fortune or of misfortune, in the uninterrupted history of the development of man. It does not become man to attempt to direct worldly events, which being long before prepared in the womb of time, only partly belong to the century into which he would transpose them.

The first discovery of the middle and southern parts of the United States and of North America, by the Scandinavians, was almost contemporaneous with the mysterious appearance of Manco Capac, in the high-lands of Peru; it was 200 years before the arrival of the Aztekes in the valley of Mexico. The foundation of their principal city (Tenochtitlan) was full three hundred and twenty-five years later. If these Norman colonizations had had very lasting results, or if they had been cherished and supported by a powerful and politically united mother country, the *Germanic* races would have encountered in their discoveries many restless hordes of hunters, instead of the domesticated agricultural tribes found there by the *Spanish* conquerors ([315]).

The times of the *Conquista*, namely, the end of the fifteenth and the beginning of the sixteenth centuries,

represent a wonderful coincidence of grand events in the political and moral life of the European nations. In the same month in which Hernan Cortes, after the battle of Otumba, moved towards Mexico in order to besiege it, Martin Luther burnt the Papal Bull at Wittenberg, and founded the Reformation, which promised mental freedom and progress in an hitherto untried path (316). Before this time, as it were from their graves, the most splendid productions of Grecian art appeared; the Laocoon, the Torso, the Apollo Belvedere, and the Venus de Medici. Michael Angelo, Leonardo da Vinci, Titian, and Raphael, flourished in Italy; in Germany, Holbein and Albert Durer. The arrangement of the planetary system was discovered by Copernicus, if not actually published, in the year in which Christopher Columbus died,—fourteen years after the discovery of the New Continent.

The importance of this discovery, and of the first European settlements, also affects other subjects besides those to which these pages are specially devoted; namely, the intellectual and moral effects produced by the sudden increase in the stock of ideas upon the improvement of the social condition of mankind. We may record, how, since that grand era, a new and active state of the intellect and feelings, bold wishes and hopes scarcely to be restrained, have gradually penetrated into the whole of civil society; how the scanty population of an hemisphere, especially the coasts opposite Europe, favoured the settlement of colonies, which, in rendering themselves extensive and independent in position, have overturned unlimited states by their choice of a free form of government; and lastly, how the reformation, a fore-

runner of vast political revolutions, had to pass through different phases of its development in one country which had become the place of refuge for all religious opinions, and for the most varied ideas of divinity. The boldness of the Genoese mariner is the first link in the immeasurable chain of these pregnant events. Accident, and not fraud and artifice, was the means of taking the name of Columbus from the continent of America(317). Through commercial intercourse and the perfection of the art of navigation, for the last half century, the new world has been brought nearer to Europe, and has exercised an important influence upon the political institutions (318), the ideas and tastes of the nations bordering the eastern side of the valley of the Atlantic, which thus appears daily to have been growing narrower.

VII.—THE GRAND DISCOVERIES IN THE HEAVENS FROM THE EMPLOYMENT OF THE TELESCOPE—THE PRINCIPAL EPOCHS OF ASTRONOMY AND MATHEMATICS, FROM GALILEO AND KEPLER, TO NEWTON AND LEIBNITZ—THE LAWS OF THE MOTIONS OF THE PLANETS, AND THE THEORY OF GENERAL GRAVITATION.

In our attempts to reckon the stages in the development of a general view of the creation in its most distant periods, we have last of all represented the age in which a second hemisphere became known to the civilized nations of one half of the globe. A considerable portion of the sky was taken possession of by the telescope in the age immediately after the time when the great discoveries of new regions upon the surface of our planet were made. The employment of a newly-invented organ or instrument, with power to penetrate into distant space, called forth an entirely new world of ideas. The bright age of astronomy and mathematics began; and, for the latter study, a long series of acute inquiries commenced, leading to Leonard Euler, "who transposed every thing," the year of whose birth, 1707, is so near to the date of Jacob Bernoulli's death.

A few names will suffice to represent these gigantic steps made by the human mind in the course of the seventeenth century, especially in the development of mathematical thoughts, induced by the innate powers of the intellect and not by external occurrences. The laws governing a falling body and the movement of the planets became known. The pressure of the atmosphere, the propagation of a ray of light, its refraction and polarization were investigated. A mathematical study of Nature was established and founded upon a firm superstructure. The discovery of the differential calculus indicates the end of the century; with the aid of this method of reckoning, during the following hundred and fifty years, the human intellect fortunately arrived at the solution of problems presented to its notice by the disturbances in the motions of the heavenly bodies, the polarization and interference of rays of light, the radiation of heat, the circle of the electro-magnetic fluid, the vibration of strings and of surfaces, the capillary attraction of narrow tubes, and many other natural phenomena.

The progress of development in the world of ideas increases uninterruptedly from this point, and gains support from every side. None of its earlier germs were extinguished. There is a simultaneous increase in the store of material for inquiry, in the strictness of the methods of examination, and in the perfection of the instruments used. We here limit ourselves principally to the seventeenth century, the age of Kepler, Galileo, and Bacon, of Tycho, Descartes, and Huygens, of Fermat, Newton, and Leibnitz. The performances of these distinguished men are so well known that it only requires me to point out,

in a few particulars, the ways in which they added to the splendid progress of general views of the creation.

I have already shewn ([319]) how the eye, our organ for receiving sensible impressions of the world and external objects, received a power by the discovery of the telescope, the limits of which have not yet been obtained, but which, even at the first small commencement, when the magnifying power of the instrument amounted only to thirty-two (linear) ([320]), reached into distant regions of the universe, until that time unexplored. A close acquaintance with the heavenly bodies belonging to our solar system, the eternal laws according to which they revolve in their course, and a complete insight into the structure of the earth, characterize the age which I am here attempting to delineate. What this epoch produced, includes the chief outlines of a great *natural picture of the world;* it adds the newly-recognized contents of the sky, clearly arranged in one system of planets at least, to the knowledge of the structure of the earth, which had been obtained by previous research. In our attempt to lay down general ideas, we must here content ourselves with naming the most important subjects of astronomical labour in the seventeenth century. We will, at the same time, point out the influence which the discoveries of this age have exercised upon a strong inducement to search for great and unexpected mathematical results, and to encourage a more comprehensive and elevated idea of the universe.

We have already shown that the age of Columbus, Gama and Magellan, namely, that of the grand nautical undertakings, was pregnant with important events, and

that it coincided with the great occurrences, the awakening of freedom of thought in religious matters, the development of a noble taste for art, and the spread of the Copernican system of astronomy. Nicholas Copernicus (in two of his letters which are still extant, he calls himself Koppernik) had attained his twenty-first year, and was making observations in conjunction with Albert Brudzewski, at Cracow, at the time when Columbus discovered America. Scarcely a year after the death of the great discoverer and after a residence of sixteen years in Padua, Bologna and Rome, we find him again at Cracow, employed in overturning all the previous knowledge of the universe. By the favour of his uncle, Bishop of Ermland, Lucas Wassailrode von Allen ([321]), he was made Canon of Frauenburg in 1510, and there he worked for three and thirty years to complete his book *de Revolutionibus orbium cœlestium*. The first printed copy of this work was brought to him, when, broken down in body and mind, he was already preparing for his death. He saw it, and even noticed it, but his senses were no longer directed to temporal concerns; he died, not as Gassendi says in his life of Copernicus, a few hours ([322]), but many days afterwards, on the 24th of May, 1543. Two years before this time, an important part of his doctrines had been made known by the publication of a letter of his most zealous pupil and follower, Joachim Rhæticus, to Johann Schoner, professor at Nuremberg. But it was not the spread of the system of Copernicus, the resuscitated doctrine of a central sun, and of the daily and yearly movements of the earth, leading to the splendid discoveries in the heavens, half a century after his first appearance, which

characterizes the beginning of the seventeenth century. These discoveries were the consequence of an accidental invention of the telescope. The fundamental views of Copernicus were strengthened and extended by the results of *physical* astronomy, namely, the discovery of Jupiter's satellites, and the phases of Venus, and these results pointed out the way to *theoretical* astronomy, which must lead to secure ground, and which rendered it necessary to complete the analytical calculus. As George Peurbach and Regiomontanus (Johann Müller of Konigsberg in Franconia), had a beneficial effect on the studies of Copernicus and his pupils Rhæticus, Reinhold, and Möstlin, so had the latter, although they were more distantly removed in point of time, upon the works of Kepler, Galileo, and Newton. This is the connection of ideas between the sixteenth and seventeenth centuries; and we cannot represent the extended notions of astronomy prevalent in the latter age, without alluding to the inducements to study this branch of science which flowed into it from the former.

It is a false, and, unfortunately, even in our time ([323]), a very prevalent opinion, that Copernicus, from fear and apprehension of ecclesiastical persecution, represented the movement of the earth round the sun and the situation of the sun in the centre of the entire system of planets, as a mere hypothesis, which answered the astronomical purpose of making the course of the heavenly bodies in a convenient way a subject of calculation, "but that it neither had any occasion to be true, nor yet to be even probable." These singular words ([324]) are certainly to be found in an anonymous report which precedes the work

of Copernicus, and which is headed "*De Hypothesibus hujus operis*;" it contains, however, expressions quite foreign to the ideas of Copernicus, and in direct contradiction with his dedication to the Pope Paul III. The author of this preface, as Gassendi says, in the most decided way, in his life of this great man, was a mathematician who lived at that time at Nuremberg, Andreas Osiander, who, with Schoner, undertook the printing of the book *De Revolutionibus*, and who, although he makes mention of no theological scruples, yet he considers it advisable to call the new opinions an hypothesis, and not, like Copernicus, to declare them to be a confirmed truth.

The founder of our present knowledge of the system of the universe, (for, at any rate, its most important parts and the grandest sketch of a picture of the universe, belong to him), was almost more distinguished by the courage and confidence with which he came forward, than by his knowledge. He deserves, in a high degree, the fair praise which Kepler gives him, when, in his introduction to the "Tables of Rudolphi," he calls him "the man with a free spirit;" *vir fuit maximo ingenio et, quod in hoc exercitio* (in the strife of prejudices) *magni momenti est, animo liber.*" When Copernicus, in his dedication to the Pope, describes the origin of his work, he does not hesitate to call the general opinion of the dogmas respecting the immobility and central position of the earth, an absurdity (*acroama*) and to attack the stupidity of those who adhere to this false belief. "If, at any time, mere babblers (ματαιολόγοι) in complete ignorance of mathematics, would pronounce sentence upon his

work, by purposely perverting some passage of the holy Scriptures (*propter aliquem locum scripturæ male ad suum propositum detortum*) he would altogether despise so rash an attack! Let it be universally known that the distinguished Lactantius, who certainly cannot be reckoned amongst mathematicians, expressed himself in a childish way (*pueriliter*) respecting the form of the earth, and despised those who considered it to be of the form of a globe. A mathematician alone should write upon mathematical subjects." In order to show that he was deeply convinced of the soundness of his results, and that he feared no expression of opinion, he turns "from a distant corner of the earth towards the head of the church, for defence against the sting of calumniators, since the church herself may derive advantage from his investigations respecting the length of the year, and the motion of the moon." Astrology, and the improvement of the calendar, for a length of time, were the only defenders of astronomy in the world in general and amongst the ecclesiastics, in the same way as chemistry was at first only of service in promoting the study of medicine.

The language of Copernicus is powerful and free, and bursts forth from his inmost convictions, and thus sufficiently refutes the ancient opinion, that he has brought forward the system which is immortalized by his name, as an hypothesis made for the convenience of calculating astronomers, or for one which has but a probable foundation. "By no other arrangement," he says in a spirited way, "have I been able to find a wonderful symmetry in the universe, and such an harmonious connexion of the paths of the heavenly bodies, as when I

place the "lantern of the world" (*lucernam mundi*), the sun, to manage the entire family of revolving stars (*circumagentem gubernans astrorum familiam*) as it were in the midst of a beautiful temple of nature, seated upon a royal throne (325)." Also the idea of the general weight or attraction (*appetentia quædam naturalis partibus indita*) towards the centre of the world (*centrum mundi*), the sun, to which he arrives by considering the attraction of globular bodies, appears to have floated before this great man's mind, as is indicated in a remarkable passage (326) in the ninth chapter of the first book of the "Revolutions."

If we look through the various steps in the development of a general idea of the creation, we shall see in the earliest times, traces of a knowledge of the attraction of gravitation and of centrifugal power. Jacobi, in his inquiries respecting the mathematical knowledge of the Greeks, which is still in manuscript, slightly dwells upon "the deep acquaintance with nature shown by Anaxagoras, from whom we hear with wonder, that the moon (327), as soon as its course is stopped, will fall to the earth, like a stone in a sling." I have already had occasion, when speaking of the fall of aerolites (328), to allude to similar expressions of Anaxagoras of Clazomenæ, and of Diogenes of Apollonia, concerning a "remission of rotatory power." Plato certainly had a clearer idea than Aristotle, of the force of attraction which the centre of the earth exercises towards all heavy masses removed from it; he knew, with Hipparchus, the increase of speed attained by a falling body, without being able rightly to comprehend its reason. In Plato and Democritus, attraction is limited to

affinity alone, that is, to power inherent in elementary homogeneous matter (329). Johannes Philoponus, of Alexandria, a pupil of Ammonius Hermeas, who probably flourished about the sixth century, was the only one who ascribed the motion of the heavenly bodies to an original impulse, and connected with this the idea of a falling body, that is, the tendency of all heavy and light matter towards the earth (330). That which Copernicus guessed at, and Kepler, in his splendid work *de Stella Martis* expressed more clearly, applying it even to the ebbing and flowing of the ocean (331), is found revived and richly illustrated, in 1666 and 1674, by the acute sense of the talented Robert Hooke. With such preparations, Newton's doctrine of gravitation afforded them a grand means of changing the whole of physical astronomy into a "Mechanism of the Heavens" (332).

Copernicus, as we may see, not only from the dedication to the Pope, but also from many passages in the work itself, was tolerably well acquainted with what the ancients had brought forward respecting the structure of the universe. Nevertheless, in the time preceding Hipparchus, he only mentions Hicetas of Syracuse, whom he always calls Nicetas, Philolaus the Pythagorean, Timæus of Plato, Ecphantus, Heraclides of Pontus, and Apollonius of Perga, the great geometrician. Of the two mathematicians whose opinions most nearly resembled his own system, namely, Aristarchus of Samos, and Seleucus the Babylonian (333), he mentions the former in a very cursory way, and the latter not at all. It has been frequently supposed that, on this account, he was ignorant of the opinion of Aristarchus of Samos respecting the central

sun, and the revolutions of the earth, because the *Arenarius*, and all the works of Archimedes, were not published until a year after his death, a full century after the discovery of printing; but those who have this opinion, forget that Copernicus, in his dedication to Pope Paul III. quotes a long passage about Philolaus, Ecphantus, and Heraclides Pontus, from the work of Plutarch, "*Concerning the opinions of the Philosophers*" (III. 13), and that, in the same book (II. 24), he might read that Aristarchus of Samos reckoned the sun amongst the fixed stars. But, of all the opinions of the ancients, that which may have exercised the deepest influence upon the direction and gradual development of his ideas, was, according to Gassendi's supposition, a passage in the encyclopediac work of Martianus Mineus Capella, written in semi-barbarous language, and the *System of the Universe* by Apollonius of Perga. According to the idea of Martianus Mineus of Madaura, which has been ascribed with great confidence (334) at one time to the Egyptians, at another, to the Chaldeans, the earth rests immovably in the centre, but the sun revolves like a planet, and is accompanied by two satellites, Mercury and Venus. Such a notion of the structure of the heavens, may certainly have led the way to the idea of the attractive force of the sun. Nothing in the Almagest, in the writings of the ancients, nor in the work of Copernicus *De Revolutionibus*, justifies the supposition so strongly expressed by Gassendi, that the system of Tycho is perfectly similar to that one which is ordinarily ascribed to Apollonius of Perga. After Böckh's complete research into the subject, there can no longer be any question respecting the confusion between the system

of Copernicus with that of the Pythagorean philosopher Philolaus, according to whom, the Antichthon, or Antipodes, is not a planet of itself, but the opposite half of our planet, and who thought that the earth does not rotate, but that it moves like the sun itself, round a central fire, the vital flame of the whole system of our planets.

The scientific revolution, commenced by Nicholas Copernicus had the rare fortune to lead onwards (with the sole exception of the short retrograde movement of Tycho's hypothesis), uninterruptedly to its goal, the discovery of the true structure of the heavens. The rich store of accurate observations, contributed by the zealous opponent himself, Tycho de Brahe, originated the discovery of the everlasting laws of the movements of the planets, which prepared for Kepler's name an undying renown, and which, interpreted by Newton and proved to be theoretically and certainly true, was transferred into the bright province of thought, namely, the contemplative perception of Nature. It has been observed acutely ([335]), but, perhaps, with too small an appreciation of the free and independent spirit which brought forth the theory of gravitation, that, "Kepler wrote a book of laws, Newton wrote the spirit of the laws."

The allegorical and poetical fables of the pictures of the world by the Pythagoreans and Plato, were changeable ([336]) as the imaginations which produced them, and were partly reflected in Kepler; they warmed and cheered his frequently troubled spirit, but did not turn him aside from his first course, which he had commenced, and at the goal ([337]) of which he arrived, twelve years before his

death, on the memorable night of the 15th of May 1618. By observing the daily rotation of the earth round its axis, Copernicus had given a sufficient explanation of the apparent revolving motion of the fixed stars, and by the yearly movement of the earth round the sun, he had given an equally satisfactory solution of the most remarkable conditions of the planets (their stationary position and retrograde movement), and thus discovered the true cause of the so-called "*second inequality*" of the planets. He did not explain "*the first inequality*," namely, the unequal movement of the planets in their course. Being convinced of the ancient Pythagorean principle of the innate perfection of circular movements, Copernicus still required for his system, some of the eccentric epicycles of Apollonius of Perga, in the centre of his empty circle. The path upon which the astronomers had entered was so bold that they could not altogether free themselves from their earlier notions upon the subject.

The equal distance in which the stars remain, with respect to one another, whilst the whole vault of the heavens moves from east to west, led to the idea of a firmament, a solid crystalline sphere, upon which Anaximenes, who was not much earlier than Pythagoras, imagined that the stars were attached like nails ([338]). Geminus the Rhodian, who flourished at the same time as Cicero, doubted whether the constellations were all upon one surface; according to his ideas, some were situated higher, others deeper. The idea of a firmament for the fixed stars, was transferred to the planets; and thus arose the theory of eccentric spheres, contained one

within the other, as maintained by Eudoxus, Menæchmus and Aristotle, who discovered the *reciprocal* spheres. The theory of the Epicycles, a contrivance which easily suited the representation and calculation of the movements of the planets, after the lapse of a century, through the ingenuity of Apollonius, supplanted the hypothesis of the motionless spheres. With regard to the questions, whether, as Ideler supposes, immediately after the establishment of the museum at Alexandria, "a free motion of the planets throughout the universe was considered possible," or whether the transparent concentric spheres (according to Eudoxus, twenty-seven in number; according to Aristotle, fifty-five), as well as the epicycles which Hipparchus and Ptolemæus bequeathed to the Middle Ages, were, at those early days, generally considered to be merely ideal methods of contemplation, and not solid, or of actual substance; upon the settlement of these historical points, I will abstain from expressing myself, however much I may feel attached to such "ideal modes of côntemplation." It is, however, certain, that in the middle of the sixteenth century, when the theory of the seventy-seven concentric spheres of the learned historian Girolamo Fracastero was approved, and when, afterwards, the opponents of Copernicus searched out for every means of supporting the Ptolemæan system, the idea of the existence of *solid* spheres, circles and epicycles, which was particularly patronized by the ecclesiastics, became very extensively believed. Tycho de Brahe boasts expressly of having performed the service, by means of his reflections concerning the paths of the comets, of having first pointed out the impossibility of the existence of solid

spheres, and of having destroyed the artificial sketches which had been previously imagined. He filled the free space of the universe with atmosphere, and believed that the "opposing medium" gave rise to sounds, by the vibrations of the revolving celestial bodies. The unpoetical Rothmann believed that this renovated Pythagorean fable of the tones was untenable.

The great discovery of Kepler, that all the planets moved in ellipses round the sun, and that the sun is situated in one of the foci, at last freed the original Copernican system from the eccentric circles and from all the epicycles [359]. The system of planets now appeared, as it were, in all the grandeur of architectural simplicity; but the play and the connection of the internal impelling and sustaining forces were first disclosed by Sir Isaac Newton. How often has it been remarked in the history of the gradual development of human knowledge, that important but apparently accidental phenomena, such as the flourishing time of men of genius, are frequently crowded together in a short space of time; this is repeated in the most striking way with regard to the first ten years of the seventeenth century. Tycho, the founder of the new measuring system of astronomy, Kepler, Galileo and Lord Bacon of Verulam were contemporaries. All of them in their riper years, except Tycho, lived to see the works of Descartes and Fermat. The outline of Bacon's, "*Instauratio Magna*" appeared in the English language as early as 1605, fifteen years before the "*Novum Organon.*" The invention of the telescope and the grandest discoveries of physical astronomy (Jupiter's satellites, the spots on

the sun, the phases of Venus, and the beautiful form of Saturn) fall between the years 1609 and 1612. Kepler's speculations respecting the elliptical orbit of Mars(340) commenced in 1601, and gave origin to his work "*Astronomia nova seu Physica cœlestis,*" which was completed eight years afterwards. "By studying the course of the planet Mars," says Kepler, "we must arrive at the solution of the mysteries of astronomy, or we shall remain always in ignorance. By persevering and continued work I have succeeded in bringing the inequalities of the motions of Mars under one natural law." The generalization of the same thought led Kepler to the grand truths and ideas respecting the universe which this imaginative writer laid down in after-years in his Harmony of the World (*Harmonices Mundi libri quinque*). "I believe," says Kepler, in a letter to the Danish astronomer, Longomontanus, "that astronomy and physical science are so closely connected together that one cannot be made perfect without the other." The result of his labours respecting the structure of the eye and the theory of sight appeared in 1604, in the "*Paralipomena Vitellio,*" and his "*Dioptrica*" (341) in 1611. Thus, by the invention of new instruments for contemplating such objects, knowledge respecting the most important phenomena in the heavens, as well as respecting matters of art, was widely diffused in the short space of the first ten or twelve years of a century, commencing with Galileo and Kepler, and ending with Newton and Leibnitz.

The accidental discovery of the telescope, with its power of penetrating into distant space, was first of

all known in Holland, probably in the latter months of the year 1608. According to the newest examination of records upon the subject(342), the following are claimants for this grand invention: Hans Lippershey, born in Wesel, and a maker of spectacles of Middleburg; Jacob Adriaansz, with the surname of Metius, who is said also to have made burning-glasses out of ice; and Zacharias Jansen. The first, in the valuable letter of the Dutch ambassador, Boreel, to the physician Borelli, the author of the treatise "*De vero telescopii inventore*," written in 1655, is always called Laprey. If we determine the priority, according to the date upon which proposals were made to the States-General on the subject, Hans Leppershey has the precedence. He offered three instruments to the government, "by means of which we can see at a distance," on the 2nd of October, 1608. The offer of Metius was on the 17th of October of the same year, but he says expressly in the petition, "that by industry and thought, he had already constructed such instruments for two years." Zacharias Jansen, an optician at Middelburg like Lippershey, in company with his father, Hans Jansen, discovered the compound microscope, with an eye-piece made with a glass for dispersing the rays, in the end of the sixteenth century, probably after the year 1590: but he discovered the telescope in 1610, as the ambassador, Boreel, testifies, and used it with his friends upon terrestrial objects, but not for examining the heavens. The influence exercised by the microscope upon a deeper knowledge of the various forms and movements of all organic parts, and by the telescope

in the sudden disclosure of the regions of the heavens, was so immeasurable, that the history of the discovery must here be more particularly alluded to.

When the account of the discovery of the telescopic vision made in Holland reached Venice in May 1609, Galileo happened to be there, and he hit upon the essential parts in the construction of a telescope, and completed his instrument in Padua(343). He first directed it towards the mountain landscapes of the moon, whose highest points he tried to measure, whilst, with Leonardo da Vinci and Möstlin, he attributed the ash-coloured light of the moon to the light of the sun reflected from the earth upon the moon: with a low magnifying power, he explored the group of the Pleiades, the cluster of stars in the constellation of the Crab, the Milky-way and the group of stars in the head of Orion. Then followed in quick succession the grand discoveries of the four satellites of Jupiter, of the two handles of Saturn, that is, the ring which was indistinctly seen and not recognised as a circle, the spots of the sun and the crescentic form of Venus.

Jupiter's moons, the first of all the satellites discovered by the telescope, were seen, as it appears, almost at the same time, but quite independently of one another, on the 29th of December, 1609, by Simon Marius, at Ansbach, and on the 7th of January, 1610, by Galileo, at Padua. In publishing these discoveries, Galileo, by his work entitled "*Nuncius Sidereus*," which appeared in 1610, anticipated the "*Mundus Jovialis*" of Simon Marius, which was published in 1614(344). The latter had given the name of "Sidera Brandenburgica" to

the satellites of Jupiter; Galileo preferred the name "Sidera Cosmica," or "Medicea," the latter of which obtained most approbation at the Court of Florence. This collective nomenclature, however, did not satisfy their taste for flattery. Instead of reckoning the moons as we do, by numbers, Marius called them Io, Europa, Ganymede and Callisto; whilst Galileo, instead of making use of these mythological terms, called them by the family names of the ruling house of the Medici, namely: Catherina, Maria, Cosimo senior and Cosimo junior.

The knowledge of the system of Jupiter's satellites and the phases of Venus, had a most essential influence in establishing and diffusing the Copernican system of astronomy. The little "World of Jupiter" (*Mundus Jovialis*) afforded to an ingenious mind a perfect picture of the great system of planets and suns. It was perceived that the moons obeyed the general law discovered by Kepler; that the square of the time of revolution is in proportion to the cube of the middle distance of the satellites from the planet. Therefore Kepler, in the "*Harmonice Mundi*," speaks with a degree of firm confidence and security which philosophical freedom of thought infuses into the heart of a "German" to those upon the other side of the Alps, and says; "eighty years[315] have elapsed, during which the doctrine of Copernicus respecting the motion of the earth and the stationary condition of the sun has been read without opposition, because it was considered lawful to discuss natural subjects and to illustrate the works of God; and now, when new documents are discovered as a proof of the doctrines, documents, unknown to his (spiritual)

judges, the spread of the true system of the universe is prohibited by you under a threat of punishment!" This hinderance, the result of the ancient struggle between natural science and the Church, had been already experienced by Kepler, even in protestant Germany(346).

For the history of astronomy and for its destined establishment(347), the discovery of Jupiter's satellites indicates an ever memorable epoch. The occultation of the satellites, and their entrance into the shade of Jupiter, led to the discovery of the speed of light in 1675, and by the knowledge of this fact, to the explanation of the ellipse of aberration of the fixed stars in 1727, in which the great orbit of the earth in its annual course round the sun is reflected, as it were, upon the vault of the sky. These discoveries of Römer and Bradley have rightly been called the "keystone of the Copernican system," the clear proof of the motion of the earth.

The important aid afforded by the occultations of Jupiter's satellites in determining the geographical longitude upon the land, was known by Galileo as early as September 1612. He proposed this plan of finding the longitude to the Court of Spain in 1616, and afterwards to the States-General of Holland, and intended it for use at sea(348); but he was little acquainted with the insurmountable difficulties in the practical application of the method upon this moveable element. He wished to go to Spain with a hundred telescopes, to be made by him, or to send his son Vincenzio there. He required, as a reward, "una Croce di S. Jago" and an annuity of 4000 scudi; a small sum, says he, since at first he had been led

to hope for 6000 ducats in the house of the Cardinal Borgia.

The observation of what was called the "triple form of Saturn" (*planeta tergeminus*) followed immediately after the discovery of Jupiter's satellites. As early as in November, 1610, Galileo sent to inform Kepler, "that Saturn consisted of three stars, which mutually touched one another." This observation was the germ of the discovery of Saturn's ring. Hevelius described, in 1656, the changes in the form and the unequal handles (*Ansæ*), and their occasional total disappearance. The merit, however, of having scientifically explained all the phenomena, as depending upon a ring round the planet, belongs to the acute investigator, Huygens, who came to the conclusion in 1655, and who, according to the habit of mistrust common at the time, veiled his discovery, like Galileo, in an anagram, composed of eighty-eight letters. Dominicus Cassini was the first who saw the black line upon the ring, and recognized in 1684, that it was divisible at least into two concentric rings. I here collect together all the most wonderful and surprizing facts respecting the forms of the heavenly bodies, which one century has taught us, especially respecting a form, which has led to the most acute suppositions with regard to the original formation of the principal and secondary planets.

The spots upon the sun were first seen through the telescope by Johann Fabricius of East Friesland, and by Galileo, as it is supposed, at Padua or Venice. In publishing the discovery, Fabricius, who wrote in June, 1611, incontestibly anticipated, by a year, the account of Galileo,

in his first letter to the Burgomaster Marcus Welser, on the 4th of May, 1612. According to Arago's careful research (349), the first observations of Fabricius were made in March of the year 1611, according to Sir David Brewster, in the end of 1610, whilst Christopher Scheiner carried his own as far back as April 1611, and probably, first employed himself earnestly with the spots upon the sun in October of the same year. Of Galileo we possess but very obscure and separate notices. He probably knew the spots in April 1611; for he exhibited them publicly at Rome, in the garden of the Cardinal Bandini, in the Quirinal, in April and May of the same year. Harriot, to whom Baron Zach ascribes the discovery of the spots upon the sun on the 16th of January 1610, certainly saw three of them on the 8th of December 1610, and represented their position in a register of observations; but he did not know that he had seen spots upon the sun any more than Flamstead recognized Uranus as a planet, on the 23rd of December 1690, or Tobias Mayer on the 25th of September, 1756, when they saw it pass across the field of the telescope. Harriot recognized the sun-spots upon the 1st of December, 1611, and, therefore, five months after Fabricius had published the discovery. Galileo remarked, that the spots, "many of which are much larger than the Mediterranean, or even than Africa and Asia," occupy a definite zone upon the sun's disc. He notices that the same spots occasionally return, and he is convinced that they belong to the sun itself. His attention is particularly attracted by the difference in their size when they are in the centre of the sun, and when they are disappearing at the edge; yet, in

his remarkable second letter to Marcus Welfer, of the date of August 14th, 1612, I find nothing that indicates a notion of the unequal ash-coloured edge upon both sides of the black spot upon the margin of the sun, which was observed by Alexander Wilson, in 1773. All the dark portions of the sun were attributed by Canon Tarde, in 1620, and by Malapertus, in 1633, to small celestial bodies revolving round it, and impeding the rays of light, and they were called the Bourbon and Austrian stars (350) (*Borbonia* and *Austriaca Sidera*). Fabricius, as well as Galileo, knew that the spots were attached to the sun (351); he also noticed that some which he had early seen, disappeared and returned; and this appearance taught him the rotatory movement of the sun, which Kepler had already suspected before the discovery of the spots. The most accurate determination of the time of its revolution was made by the industrious Scheiner, in 1630. If the strongest light which has hitherto been produced by man, namely, the Drummond light, made by the use of heated lime, is thrown upon the sun's disc, it appears as black as ink; we may, therefere, hear, without surprise that Galileo, who, undoubtedly first described the great "*faculæ*" of the sun, considered the light in the nucleus of the spots as more intense than that of the full moon, or of the atmosphere immediately round the sun's disc (352). Ideas respecting the numerous envelopes of atmosphere, of clouds and light, which surround the (black) solid nucleus of the sun, are found in the writings of the Cardinal Nicholas of Cusa, in the middle of the fifteenth century (353).

To conclude the cycle of the wonderful discoveries

which scarcely comprises two years and in which the name of the great and immortal Florentine astronomer shines prominently forth, I must still mention the form of the planet Venus. As early as February, 1610, Galileo noticed that it was crescent-shaped, and, on the 11th of December, of the same year, he published this important discovery, according to the custom to which I have above alluded, under the guise of an anagram: of this Kepler speaks, in the preface to his *Dioptrics*. Also with respect to the change in the form of the illuminated portion of Mars, he believed that he recognized something peculiar, notwithstanding the low magnifying power of his telescope; and of this he speaks in a letter to Benedetto Castelli, of a date of the 30th of December, 1610. The discovery of the crescent moon-shape of Venus, was the triumph of the Copernican system. The necessity of the existence of phases could not escape the founder of this system; in the tenth chapter of his first book, he discusses circumstantially, the doubts which the more recent followers of the opinions of Plato had raised against the Ptolemean system of astronomy, with regard to the variation in the form of the illuminated part of the planets. In developing his own system he does not especially allude to the phases of Venus, as Thomas Smith supposes in his work upon optics.

The spread of general knowledge of the Creation, the delineation of which is, unfortunately, not altogether separable from the disagreeable squabbles respecting the rights of priority in the discoveries, as well as everything else which touches upon physical astronomy, was more generally striking, because the discovery of the telescope

in 1608, happened at a time when great events among the celestial bodies had excited the wonder of vast assemblies of people; these events were, the sudden appearance and extinction of three new stars, which happened respectively thirty-six, eight, and four years before; namely, in Cassiopeia, in 1572: in the Swan, in 1600, and at the foot of Serpentarius in 1604. All these stars were brighter than stars of the first magnitude, and the one noticed by Kepler, in the Swan, shone in the sky for twenty-one years, during the whole period of Galileo's discoveries. Three centuries and a half have now elapsed, and no new star of the first or second magnitude has appeared; for the remarkable celestial phenomena witnessed by Sir John Herschel in 1837, in the southern hemisphere ([354]), was the great increase in the intensity of the light in a star of the second magnitude (*η Argo*) which had long been seen, but which had not been before known to be changeable. Kepler's writings and our own experience, when comets visible with the naked eye appear, will teach us how powerfully the appearance of new stars, between 1572 and 1604, must have raised the curiosity of the people at the time, and led them to participate in astronomical discoveries, and even have given rise to a rich combination of fanciful ideas. Also terrestial occurrences, such as earthquakes in regions where they had been seldom felt previously, eruptions of volcanoes that had been for a long time quiescent, the sound of aerolites rushing through our atmosphere, and becoming heated in their course, kept alive, for a time, their interest in problems, which appeared still more difficult to the people than to the dogmatizing physical philosophers.

In these considerations respecting the influence of immediate and sensible perception of phenomena, I have particularly named Kepler, in order to record the fact, that, in this great and wonderfully gifted man, the inclination to imaginative ideas was connected with a most remarkable talent for observation, with a strict and earnest method of induction, with a bold, and almost unexampled perseverance in calculating, and with an unusual depth of mathematical genius; this was manifest in his work, the *Stereometria Doliorum,* and exerted a happy influence upon Fermat, and, through him, upon the discovery of the mode of reckoning by the differential calculus ([355]). Such a spirit ([356]) was especially suited by the fulness and quickness of his ideas, and by venturing hypotheses respecting the Creation, to increase and diffuse the vital power and activity which led on uninterruptedly in the seventeenth century to the lofty goal of a comprehensive survey of Nature.

The numerous comets visible to the naked eye, eight in number, from 1577 to the appearance of Halley's comet in 1607, and the phenomena to which I have above alluded, namely, these new stars, seen almost in the same period, gave rise to speculations respecting the origin of these celestial bodies from a cloud or vapour filling the whole of the heavens. Kepler believed, with Tycho, that the new stars had been formed from this vapour, and that they had again become dissolved in it ([357]). The comets, also, to which, before the actual establishment of the elliptical orbit of the planets, he ascribed a rectilinear path, without returning in a curved course, consisted of "heavenly atmosphere," as he mentions in his "*New and*

rare Discourse upon the Stars," published in 1608. He also added ancient notions respecting the production of organic bodies, without the process of generation, and said, that comets arise "in the same way that vegetables grow from the earth without seed, or as fishes, by *spontaneous generation* in the salt water."

Kepler was more fortunate in some of his other hypotheses, and ventured to lay down the following positions; —all fixed stars are suns, like ours, surrounded by planets; our sun is enveloped by an atmosphere which appears in total eclipses as a white circle of light; it is so situated among the great islands of celestial bodies, as to form the centre of the converging circle of stars in the milky way ([358]); it rotates round its axis as well as all the planets and fixed stars (the spots upon its surface had not been discovered at that time); satellites, such as Galileo discovered, belonging to Jupiter, will be found revolving round Saturn and Mars: in the disproportionate distance ([359]) between Mars and Jupiter, when, at the present day, we know of the existence of seven asteroids (as between Venus and Mercury), there are planets which are too small to be recognized by the naked eye. This expression of his hypotheses, and fortunate guesses at facts which were afterwards, for the greater part, discovered to be so, attracted a general interest; although none of Kepler's contemporaries, Galileo himself not excepted, alluded with sufficient praise to the discovery of the three laws which, since Newton and the establishment of the theory of gravitation, render Kepler's name immortal ([360]). General ideas respecting the universe, even those which were not founded upon

observation, but simply upon weak analogies, attracted, as is frequently the case now, more attention than the most valuable productions of calculating and scientific astronomy.

Having described the important discoveries which diffused a knowledge of the structure of the universe in so small a cycle of years, it remains for me to notice the progress made in physical astronomy, by which the second half of this great century was rendered so conspicuous. The perfection of the telescope caused the discovery of Saturn's moons. Huygens first discovered the sixth, on the 25th of March, 1655, forty-five years after the discovery of Jupiter's Satellites, through an object glass which he had himself polished. As he partook of the prejudiced idea of many of his cotemporaries, that the number of moons can never surpass the number of the principal planets ([361]), he took no further trouble to discover any other moons for Saturn. Four of them, called *Sidera Lodovicea*, were discovered by Dominicus Cassini; they were, the seventh external one, with a great variety in its degree of illumination, discovered in 1671; the fifth, in 1672; the fourth and third, in 1684, by means of Campani's object glass, of from one hundred to one hundred and thirty-six feet of focal distance; the two innermost were found by William Herschell, more than a century later, in 1780 and 1799, through his gigantic telescope. The last-named moon presents the remarkable phenomenon of a satellite revolving round its planet in less than one day.

Soon after Huygen's discovery of one of Saturn's moons, Childrey observed the zodiacal light; namely,

between 1658 and 1661, but Dominicus Cassini first determined its local relations in 1683. The latter did not consider it to be a part of the sun's atmosphere, but, like Schubert, Laplace, and Poisson, to be a distinct revolving nebulous circle ([362]). Next to the proof of the existence of moons to the planets, and of the free but still concentrically divided ring of Saturn, the supposed and probable existence of a zodiacal atmosphere is one of the grandest extensions in the knowledge of a system of planets which previously appeared so simple. In our days, the orbits of the small planets which exist between Mars and Jupiter, the inner comets, the first of which was proved to be so by Encke, and the number of falling stars which are seen on certain days (if we can consider them as anything more than small bodies moving with the speed of planets), have enriched, in a wonderfully manifold way, those general views of the Creation with new objects for research.

In the age of Kepler and Galileo, the ideas respecting the contents of the universe beyond the most external of the planets' orbits, and beyond all the paths of the comets, and respecting the subdivision of matter, were very considerably extended. In the same period in which three new stars of the first magnitude shone forth in Cassopeia, the Swan and Serpentarius, namely, from 1572 to 1604, David Fabricius, a clergyman at Ostell, in East Friesland, (the father of the discoverer of the spots on the sun), discovered in 1596, and Johann Bayer, at Augsburg, in 1603, upon the neck of the Whale, a star which again disappeared; but Johann Phocylides Holwarda, Professor at Franeker, was the first to recognise, in 1638

and 1639, its peculiar changing light, as Arago has shown in his valuable treatise on the history of astronomy [363]. The phenomenon was not isolated. In the latter half of the seventeenth century, periodically changing stars were discovered in the Medusa's head, in the Hydrus and the Swan. How accurate observations respecting the changing light of Algal, could lead to the determination of the speed of the light from this star, has been shown with great cleverness in the treatise of the date of 1842, to which I have just alluded.

The use of the telescope, at this time, also led to the close examination of a class of phenomena, some of which could not escape the vision of the naked eye. Simon Marius described, in 1612, the nebulous spot of Andromeda; Huygens sketched, in 1656, the picture of Orion's sword. Both nebulæ may serve as types of a very different, and more or less advanced condensation of the vapour-like matter of the universe. Whilst Marius compares the nebulous spot to a "nucleus of light, seen through a semi-transparent body," he represents very fairly by this resemblance, the difference between the nebulæ, properly so called, and the groups or clusters of stars examined by Galileo, as for instance, the Pleiades, and the cluster in the Crab. As early as the beginning of the sixteenth century, Spanish and Portuguese mariners, without the advantage of telescopic vision, had admired the two Magellanic light clouds, revolving round the south pole, one of which, as I have already remarked is, the white spot, or the Ox of the Persian astronomer, Abdurrahman Susi, of the middle of the tenth century. In his

work, *Nuncius Sidereus,* Galileo uses the names "Stellæ Nebulosæ," or "Nebulosæ" alone, to signify the groups of stars which are scattered in the sky, or, as he expresses it, "*ut areolæ sparsim per æthera subfulgent.*" As he thought the nebula of Andromeda, which is visible with the naked eye, but which, with the highest magnifying powers has not yet been resolved into stars, worthy of no very special notice, so he considered all the light of the nebulæ, and all his "Nebulosæ," even the Milky Way itself, to be due to a number of stars very closely collected together. He did not distinguish the nebulæ from the stars, as Huygens does in the constellation of Orion. These are the feeble commencements of the grand works upon the subject of the nebulæ, which have afforded to the astronomers of our time such laudable occupation in both hemispheres.

The seventeenth century owes its principal splendour, in its beginning, to the sudden extension of astronomical knowledge by means of Galileo and Kepler, and at the end, to the progress of pure mathematics by Newton and Leibnitz; at the same time, the principal part of the physical problems which occupy us at the present day, experienced in that day a very beneficial and fertilizing degree of care. To preserve for my History of a physical Contemplation of the World, its characteristic peculiarities, I limit myself solely to the mention of the works which exercised an immediate and essential influence in extending general views of Creation. Among those who promoted the study of the phenomena of light, heat and magnetism, I first name Huygens, Galileo and Gilbert. When Huygens was studying the double re-

fraction of light by a crystal of Iceland spar, that is, the subdivision of one ray into two, he discovered in 1678, the mode of polarizing light which bears his name. The discovery of this isolated phenomenon which was first published in 1590, and, therefore, five years before his death, was followed a hundred years afterwards, by the discoveries of Malus, Arago and Fresnel, Brewster([364]) and Biot. Malus discovered in 1808 the method of polarizing by reflection from the surfaces of mirrors; Arago, in 1811, the production of colours by polarization. A world of wonders was now disclosed, namely, that of waves of light endowed with manifold and various new properties. A ray of light, which reaches our eye from a distance of many millions of miles declares of itself in Arago's polariscope, whether it is refracted or reflected: whether it emanates from a solid, fluid or gaseous body ([365]); it also declares its degree of intensity. In this way we are brought back to the seventeenth century by Huygens, and are instructed concerning the constitution of the sun and its envelopes, concerning the reflected or direct light of comets' tails and of the Zodiacal light, concerning the optical peculiarities of our atmosphere and the position of four "neutral points" of polarization ([366]), discovered by Arago, Babinet and Brewster. In this way man obtained for himself new instruments which, skilfully applied, tend to advance his acquaintance with Nature.

Next to polarization, I must also mention the most striking of all optical phenomena, namely, the *Interference* of rays of light, feeble traces of which, without an intelligible idea of the conditions necessary to give

rise to it[367], were noticed by Grimaldi in 1665, and by Hooke. The discovery of these conditions, and the clear knowledge of the laws by which rays of unpolarized light neutralize one another and produce darkness, came down to us from the very same sources, but by a longer route; and for them, our more modern times have to thank the good fortune and acuteness of Thomas Young. The laws of the interference of polarized light were discovered in 1816 by Arago and Fresnel. The "undulatory theory," proposed by Huygens and Hooke, and supported by Leonhard Euler, at last obtained a firm and solid footing.

If the latter half of the seventeenth century was distinguished for the promotion of optical science by the attainment of an insight into the nature of double refraction, yet it obtained a much greater degree of renown by Newton's experimental works, and by Olaus Römer's discovery of the measure of the speed of light, made in 1675. Half a century later, namely, in 1728, Bradley established this discovery, so that the changes found out by him in the apparent situation of a star, in consequence of the movement of the earth in its orbit were to be considered as connected with the propagation of a ray of light. Newton's splendid work upon optics appeared in 1704, for personal reasons, two years after Hooke's death, and in the English language; but it is certain that this great man was in possession[368] of the principal points in his ideas upon optics, namely, his theory of gravitation and the differential calculus, (method of fluxions), even before the years 1666 and 1667.

In order to preserve entire the common bond of union which includes all the general primitive phenomena of matter, and after having mentioned in an aphoristic way the optical discoveries of Huygens, Grimaldi and Newton, we must introduce and allude to the reflections upon terrestrial magnetism and the temperature of the atmosphere, as far as these studies were commenced in the course of the century which I have here undertaken to delineate. The most talented and valuable work upon the magnetic and electrical forces, namely, William Gilbert's "*Physiologia nova de Magnete,*" appeared in the year 1600. I have had an opportunity of speaking of it several times(369). This man(370), who was so much admired by Galileo on account of his acuteness, anticipated a great deal of what we now know. He considered magnetism and electricity as two emanations of an original power, which is innate in all matter. He therefore treats of both together. Such obscure guesses concerning the effect of the loadstone upon iron, and the power of attraction in amber for dry chaff, when it is "enlivened," as Pliny says, by heat and friction, are found in all ages, and in all races, among the Ionian natural philosophers and the Chinese physical investigators(371). According to William Gilbert, the earth itself is a magnet, and the curves of equal variation and inclination depend upon the distribution and forms of the vast continents, and of the shape and expanse of the deep basins of the ocean lying between them. The periodical changes which characterize the three principal forms of magnetic phenomena, namely, the *isoclinic, isogonal* and *isodynamic,* are with difficulty con-

nected with this inflexible system of the distribution of forces and of masses, unless we represent the power of attraction of the material particles as being modified by the equally periodical changes in the centre of the globe of the earth.

In Gilbert's theory, as in the theory of gravitation, he only takes cognizance of the quantity of matter, without any regard to its heterogeneous quality. This circumstance, in the time of Kepler and Galileo, gave a character of universal importance to his work. By means of Arago's unexpected discovery of rotatory magnetic instruments in 1825, it has been actually proved that all kinds of matter are susceptible of magnetism; the most recent labours of Faraday respecting diamagnetic substances prove the important fact that, under certain conditions of the direction with regard to the meridian or the equator, bodies in a solid, fluid or gaseous state will give a similar result. Gilbert had so clear an idea of the communication of terrestrial magnetism, that even at that time he ascribed the magnetic condition of the iron rods upon the crosses of old church towers([372]) to this influence of the earth.

The increasing activity of navigation as far as the highest latitudes, and the perfection of magnetic instruments, of which the dipping needle (inclinatorium) constructed by Robert Norman of Ratcliffe, in 1576, forms a part, tended to render the knowledge of the periodical advance of a part of the magnetic curves, namely, the lines without magnetic variation, much more general during the course of the seventeenth century. The situation of the magnetic equator, which had long been

considered identical with the geographical equator, was left unexplored. Observations upon the dip of the needle were only made in some of the principal towns in the west and south of Europe, and the measurement of the intensity of the magnetic power of the earth, which varies according to time and space, was attempted by Graham at London, in 1723, by means of the oscillations of a magnetic needle; but after Borda's fruitless undertakings upon his last voyage to the Canary Islands in 1776, Lamanon had the good fortune of being the first to compare together the intensity in different zones of the earth; and this took place during La Pérouse's expedition in 1785.

Upon the strength of a vast multitude of observations respecting the dip of the needle which already existed at his time, made by Baffin, Hudson, James Hall and Schouten, and which were of very unequal value, Edmund Halley sketched his theory of four magnetic poles, or points of convergence, and of the periodical movement of the magnetic line without variation, in the year 1683. To prove this theory, and to perfect it by the aid of new and accurate observations, the English government allowed him to make three voyages in the Atlantic Ocean, from 1698 to 1702, in a ship which he himself commanded. In one of these voyages, he arrived as far southwards as the fifty-second degree of south latitude. This enterprise made an epoch in the history of terrestrial magnetism. The result of it was a general "map of the variations," in which all the points where the sailors had found the variation to be the same were connected by curved lines. I believe that before

this time, no government had ever fitted out a naval expedition for an object, by the attainment of which the practice of navigation might be promoted so much, but which at the same time properly deserves to be called an enterprize for scientific and physico-mathematical purposes.

But since no phenomenon can be separately established by an attentive inquirer, without his considering its relation to others, Halley, upon his return from his voyages, ventured the supposition that the northern light was a magnetic phenomenon. In my general "Picture of Nature," I have already remarked that Faraday's splendid discovery, namely, the development of light by magnetic power, has raised that hypothesis, which was put forward in 1714, to the level of an empirical certainty.

But if the laws of terrestrial magnetism are to be thoroughly investigated in the great cycle of the periodical advance of all three kinds of magnetic curves, it is not sufficient to observe the daily regular or disturbed course of the needle in the "magnetic stations," which, since 1828, have began to cover a considerable portion of the earth's surface([373]); but four times in every century an expedition of three ships should be sent out to examine, as nearly as possible at the same time, the condition of the magnetism of the earth as far as the surface that is covered with water will permit. The magnetic equator, that is, the curved line at which the dip amounts to nothing, should be determined not only according to the geographical longitude of the places where it intersects the geographical equator, but the course of the ship should be perpetually altered according to the

inclination of the needle, so as never to leave the direction of the magnetic equator. Expeditions by land should be united with these undertakings, and wherever the country cannot be altogether traversed, it should be particularly noticed upon what points of the shores the magnetic curves, especially the lines without variation, impinge. The two isolated and enclosed systems of lines, of an oval form, with almost concentric curves of variation, in East Asia and in the South Sea, in the meridian of the Marquesas Islands(374), deserve that attention should be especially directed to their movement and gradual expansion. As so much light has been thrown upon the geography of the southern hemisphere respecting the polar distances, and as the position of the magnetic south pole has been empirically made out by the famous expedition of Sir James Clark Ross, who was furnished with such splendid instruments, between the years 1839 and 1843, and as the great mathematician of the age, my noble friend, Friedrich Gauss, has succeeded in laying down the first general theory of terrestrial magnetism, we need not yet give up the hope that, with such numerous requirements of science and navigation, this plan, which I have already so frequently brought forward, will really be carried into effect. Would that the year 1850 may be fixed upon as the first normal epoch in which the materials for the formation of a *magnetic chart of the world* will be collected together; and that permanent scientific institutions (academies) would make it a rule every twenty or twenty-five years, to remind the governments favourable to the advance of nautical science, of the

the importance of the undertaking, the universal value of which is connected with its frequent repetition over long space of time!

The discovery of instruments for measuring heat first turned their thoughts to explore the modifications in the atmosphere by a series of consecutive and connected observations: Galileo's thermoscope, invented in 1593 and 1602, was independent of changes in temperature and the pressure of external air([375]). We learn from the *Diario* of the Academia del Cimento, which in the short duration of its existence had so powerful an influence in exciting a love for the systematic performance of experiments, that observations upon the temperature were made five times daily([376]) as early as 1641 by thermometers made with alcohol, like ours, in many stations; at Florence in the monastery *degli Angeli,* in the plains of Lombardy, in the mountains of Pistoja, and in the highlands of Innspruck. The Grand-Duke, Ferdinand II, employed the monks in many monasteries of his dominions with this work([377]). The temperature of the mineral springs was also determined at that time, and this gave origin to many questions respecting the temperature of the earth. As all natural phenomena and all changes in earthly matter are connected with modifications of heat, light or electricity, either at rest or running in streams, and as the phenomena of heat seen in the expansion of bodies are most within the range of perception by the senses, the discovery and perfection of means for measuring temperature, as I have already elsewhere remarked, must indicate an important epoch in the progress of a general acquaintance with Nature's laws. The scope

for the use of the thermometer and the rational consequences which may be deduced from its indications, are as immeasurable as the powers of Nature itself, which manifest themselves in the atmosphere, upon dry land, or in the several consecutive layers of water in the ocean, in inorganic matter and in the chemical vital processes of the organic world.

The effects of radiating heat were also investigated more than a hundred years before Scheele's great works, by the Florentine members of the Academy del Cimento, by means of remarkable experiments with concave mirrors, opposite which, non-luminous heated bodies and masses of ice, as much as five hundred pounds weight, were placed to radiate really and apparently ([378]). In the end of the seventeenth century, Mariotte examined the relations of radiating of heat in its passage through plates of glass. These isolated experiments must here be mentioned, because, in later times, the doctrines of the radiation of heat threw a great light upon the cooling of the earth's surface, the formation of dew, and many general climatic modifications, and by Melloni's remarkable ingenuity, have led to a knowledge of the contrast in the permeability to heat (diathermancy), in rock salt and alum.

The inquiries respecting the temperature of the atmosphere, as it is changed in relation to the geographical latitude, the season of the year and the elevation of the soil, soon became connected with others respecting the varying pressure and quantity of vapour in the air, and respecting the frequently observed periodical order of changes of the direction of the winds. Galileo's correct views of the atmospheric pressure led Torricelli, a year

after the death of his great teacher, to attempt the construction of the barometer. Claudio Beriguardi (379) of Pisa, was, as it appears, the first to notice that the column of quicksilver, in Torricelli's tube, was higher at the bottom of a tower or of a hill, than upon the summit; and five years later, it was observed in France, at the request of Pascal, by Perrier his brother-in-law, on mounting the Puy de Dome, eight hundred and forty feet higher than Vesuvius. The idea of using the barometer for measuring heights now obviously presented itself; and was probably first awakened in Pascal by a letter of Descartes (380). It does not require any special discussion in this place to establish the aid afforded by the barometer as a hypsometrical instrument, for determining the level of the surface of the earth in particular positions, and as a meteorological instrument, for investigating the influence of currents in the air, in extending a physical description of the earth, and the study of atmospheric phenomena. The theory of the currents in the air, to which I have just alluded, was also known in its fundamental portions before the end of the seventeenth century. Bacon has the merit of having considered the direction of the winds, in its dependence upon the temperature, and the amount of watery vapour in the atmosphere, in his distinguished work, *Historia naturalis et experimentalis de ventis* (381), in the year 1644; but in direct contradiction to the mathematical correctness of the Copernican system, he fabulously brought forward as a possibility, "that our atmosphere moves daily round the earth, in the same way that the sky does, and that the tropical east winds are caused in this way."

Hooke's universally comprehensive genius here also originated regular laws, and at the same time, threw considerable light upon the subject (382). He recognized the influence of the rotation of the earth; and the upper and lower strata of warm and cold air, rushing from the Equator to the Poles and returning from the Poles to the Equator, were known to him. Galileo, in his last dialogue, certainly considered the trade winds to be a consequence of the rotatory movement of the earth; but he attributed the fact of the air being left behind within the tropics, notwithstanding the speed of the earth's rotation, to a purity and clearness of the atmosphere in those regions (383). Hooke's more accurate ideas were again taken up, in the eighteenth century, by Halley, and were more circumstantially and satisfactorily illustrated according to the effect of the speed of rotation in each parallel of latitude. Halley, by his long residence in the torrid zones, was induced, at an earlier date, namely in 1686, to publish a splendid work detailing facts respecting the existence of the trade winds and monsoons. We cannot but be surprised, that in his magnetic expeditions, he does not mention the laws of the change of the winds, which are so important for the whole of meteorology, since they were known in their general characters by Bacon and Johann Christian Sturm, of Hippolstein, who was, according to Brewster (384), the true discoverer of the differential thermometer.

In the glittering age of the establishment of mathematical natural philosophy, there was no want of experiments for investigating the moisture of the atmosphere in connection with change of temperature, and the direction

of the wind. The Academy del Cimento had the happy thought of determining the quantity of moisture by evaporation and precipitation. The oldest Florentine instrument was a *condensing hygrometer*; an apparatus in which the quantity of water that was condensed and ran down, was determined by weight (385). Absorbing hygrometers, made by Santori in 1625, by Torricelli in 1646, and by Molineux, out of substances from the animal and vegetable kingdoms, by the advice and example of Leonardo da Vinci (386), were used at the same time as the condensing hygrometer, the idea of which was gradually improved by Le Roy, and led, in our days, to the accurate psychrometrical methods of Dalton, Daniell, and August. Strings of catgut and the bristles of plants were employed at the same time. These instruments, the action of which depended upon the absorption of the moisture contained in the atmosphere by organic tissues, were supplied with indicators and little balances, and their construction corresponded with that of the hair and whalebone hygrometers of Saussure and Deluc: but the power of determining certain fixed points in dryness and moisture, so necessary in comparing and understanding the results, which at last was discovered by Regnault, was wanting in the instruments of the seventeenth century, although the sensibility of the substance used for hygrometric purposes, was extremely persistent. Pictet found that the hair of a Guanchee mummy from Teneriffe, probably a thousand years old, which was used in a hygrometer of Saussure, was still sufficiently sensitive (387).

Electricity was recognized by William Gilbert as the effect of a peculiar power of Nature allied to that of

magnetism. The book in which this view was first expressed and in which the words "electrical power," "streams of electricity," and "electrical attraction," (388) were first used, is the work to which I have so frequently alluded, and which appeared in the year 1600, entitled "*The Physiology of the magnet and the Earth as a great magnet* (*de magno magnete tellure*). "The power," says Gilbert, "of attracting light bodies of every kind, after being rubbed, is not peculiar to amber alone, which is an inspissated terrestrial juice thrown up by the waves of the sea, and in which flying insects, ants and worms are imprisoned, as it were in eternal tombs (*sepulchris æternis*). Attraction belongs to an entire class, composed of very different substances; as glass, sulphur, sealing-wax, and all kinds of resin, to rock crystal and all precious stones, to alum and rock salt." Gilbert measured the strength of the electricity that was induced upon a little needle, not made of iron, moving freely upon a point (*versorium electricum*); very like the apparatus which Hauy and Brewster employed in testing the electricity of minerals when rubbed and heated. "Friction," says Gilbert again, "produces powerful effects with dry and damp air; rubbing with a silken cloth is the most advantageous. The globe of the earth is held together by an electrical power (?) (*Globulus telluris per se electrice congregatur et cohæret*); for the electrical power proceeds from the union and agglomeration of its parts (*motus electricus est motus coacervationis materiæ*)." In these obscure axioms is expressed the idea of *terrestrial electricity*; the manifestation of a power which, like magnetism, belongs essentially to matter. To the repelling power of the magnet,

and the difference between conductors and non-conductors, there is, at the date I speak of, no allusion whatever.

The sensible discoverer of the air-pump, Otto von Guerike, first noticed the existence of more than the mere phenomena of attraction. In his experiments on electricity, produced by rubbing a piece of sulphur, he recognized the phenomena of repulsion, which afterwards led to the discovery of the laws of the effects and of the distribution of this agent. He heard the first sound, and saw the first light in spontaneously induced electricity. In the account of an experiment which Newton made in 1675, we see the first traces of an electric charge by rubbing a plate of glass ([389]). We have here merely inquired into the first germs of an acquaintance with this power, which, in the wonderful development it subsequently attained, has not only become one of the most important branches of meteorology, but which has thrown so much light upon the deeper effects of terrestrial forces, since the time when we learned that magnetism is one of the various forms under which it is manifest.

Although the identity of electricity produced by friction, and lightning, was suspected by Wall in 1708, and by Stephen Gray in 1734, yet the certainty of the fact was first known about the middle of the eighteenth century, by the fortunate endeavours of Benjamin Franklin. From that period of time, the electrical process stepped forth from the province of speculative physical philosophy into the province of an universal contemplation of Nature, that is, out of the study into the freedom of Nature. The study of electricity, like that of optics and magnetism, had

long epochs of very feeble development, until, in these three branches of physical science respectively, the works of Franklin and Volta, Thomas Young and Malus, Oersted and Faraday, roused their cotemporaries to an admirable degree of activity. The progress of human knowledge is closely connected with this interchange from a state of slumber to a condition of suddenly awakened energy

But although, as I have just observed, the relations of the temperature, the changes in the atmospheric pressure, and the moisture of the air, had become objects of immediate research, by the discovery of suitable, but, at the same time, very imperfect physical instruments, and by the acuteness of Galileo, Torricelli and the members of the Academia del Cimento; yet, on the other hand, everything relating to the chemical composition of the atmosphere remained enveloped in obscurity. Certainly the foundations of *Pneumatic Chemistry* were laid by Johann Baptist van Helmont, and Jean Ray, in the first half of the seventeenth century, and, in the latter half by Hooke, Mayow, Boyle and the dogmatizing Becher; but however striking their correct comprehension of certain individual and important phenomena was, yet they failed altogether in connecting them together. The ancient belief, that the air, consumed in combustion, in the oxidation of the metals and in breathing, was a simple element, proved an obstacle extremely difficult to overcome.

The inflammable gases and those which extinguished fire, in caves and mines (the *spiritus letales* of Pliny) and the disengagement of these gases in the form of bubbles

in bogs and mineral springs (called spirits of the ditches and wells), attracted the attention of the Benedictine monk of Erfurt, Basil Valentine, probably at the end of the fifteenth century, and of Libavius, an admirer of Paracelsus, in 1612. They instituted a comparison between what was accidentally observed in the laboratories of the alchemists, and what they saw prepared in the vast workshops of Nature, especially in the centre of the earth. The practice of mining, in places where metallic ores were found, (especially those combined with sulphur, which produce heat by oxidation and electricity by contact), led to theories respecting the chemical union between metals, acids and the admission of external air. Paracelsus even, whose fanciful vagaries were cotemporaneous with the first discovery of America, noticed the development of gas during the dissolution of iron in sulphuric acid. Van Helmont, who first made use of the term "Gas," distinguishes it from atmospheric air, and from vapours, because of its want of the property of becoming condensed. The clouds, according to his ideas, were vapours, and they became gas when the sky was very clear, "by coldness, and by the influence of the stars." Gas can only become water if it is previously changed again into vapour. These are the views respecting meteorological phenomena prevalent in the beginning of the seventeenth century. Van Helmont was not acquainted with the simple means of collecting and separating his *gas sylvestre,* under which name he includes all inflammable gases incapable of supporting combustion or respiration, and different from pure atmospheric air; still he burnt a light under a glass isolated over water,

and noticed, when the flame was extinguished, that the water pressed into the glass and that the volume of the air was decreased. Also, by determining the weight, as we find from Cardanus, Van Helmont attempted to shew that all the solid parts of vegetables were formed of water.

The opinion of the alchemists of the middle ages respecting the composition of the metals, and of their loss of splendour by combustion (incineration, conversion into earth, and calcination) with access of the atmospheric air, induced them to inquire into the phenomena accompanying the process, and what changes the metals, which were calcined or converted into earths, and the air in contact with them, underwent. Cardanus, in the year 1553, perceived the increase in weight of lead during oxidation, and ascribed it, altogether in accordance with the fabulous notion of *Phlogiston,* to a "divine substance of fire," which had the property of making things lighter; but eighty years afterwards, Jean Rey, a very skilful conductor of experiments, at Bergerac, who had examined with greater accuracy the increase of weight of the oxides of lead, tin and antimony, first expressed the important result of his undertakings that the increased weight is to be ascribed to the addition of air to the calcined metals. He says: "Je responds et soustiens glorieusement que ce surcroît de poids vient de l'air qui dans le vase a esté espessi" [390].

They had now arrived at the road which led them to the chemistry of our days, and by means of it, to acknowledge of a grand phenomenon in the order of the Creation;

namely, the close connection between the oxygen of the atmosphere and the vitality of plants. The connection of ideas, however, which the most distinguished men of that time followed, was of a remarkably complex nature. About the end of the seventeenth century, a belief in particles of saltpetre, (*spiritus nitro-aëreus, pabulum nitrosum*), was expressed, in an obscure manner by Hooke in in his "*Micrographia*" of 1665; in a more complete way by Mayow in 1669, and by Willis in 1671: this was considered to be identical with the air fixed in saltpetre, and to be contained in the atmosphere, and to be necessary to the process of combustion. "It was supposed that the extinction of a flame in an enclosed space did not occur because the air which was present was overloaded with the vapour of the burning body, but because of the complete absorption of the *spiritus nitro-aëreus* of saltpetre originally contained in the atmosphere." The sudden and vigorous ignition which occurs, if melting saltpetre (as it is giving out oxygen) is thrown upon the fire, and the existence of saltpetre in clay walls in contact with the atmospheric air, appear simultaneously to have favoured this opinion. The nitrous particles of the air, according to Mayow, are necessary to the respiration of animals, and, in consequence of this process, animal heat is developed and the blood is rendered pure; they are necessary for all kinds of combustion, and for the calcination of metals; they act almost the same part as oxygen does in chemistry after the theory of Phlogiston had been given up. The prudent, but doubting natural philosopher, Robert Boyle, certainly knew that the presence of some constituent

of the atmospheric air was necessary to the process of combustion; but he remained in uncertainty respecting its existence in saltpetre.

Oxygen was considered by Hooke and Mayow as an ideal object, a fiction of the imagination. The acute chemist and vegetable physiologist, Hales, first recognised oxygen as a gas, which he produced in 1727 in considerable quantities from the lead calcined at Mennige, by the application of a powerful heat. He saw the disengagement of gas without inquiring into its nature, and without noticing the rapid combustion which took place in it. Hales did not anticipate the importance of the substance which he had prepared. The great development of light from bodies burning in oxygen and its properties were, as many think, discovered quite independently (391) by Priestley from 1772 to 1774; by Scheele in 1774 and 1775, and by Lavoisier and Trudaine in 1775.

The beginnings of Pneumatic Chemistry have been touched upon in these pages, with respect to their historical sequence, because, like the feeble commencement of a knowledge of electricity, they have led the way to the development in the following century of comprehensive ideas respecting the composition of the atmosphere and its meteoric changes. The idea of the existence of gases, specifically different from one another, was never very clear in the seventeenth century to those who made them. Chemists began again exclusively to ascribe the difference between atmospheric air and the kinds of gas which were incapable of supporting respiration, or of producing of heat or light, to the admixture of certain vapours. Black and Cavendish pointed out in 1766 that

carbonic acid (fixed air) and hydrogen (inflammable air) were gaseous fluids specifically different from one another. So long was the advance of science paralysed by their original belief that the atmosphere was a simple element. The ultimate examination of the chemical composition of the atmosphere, and the delicate determination of the relative quantity of its components by the beautiful works of Boussingault and Dumas, form one of the bright spots in modern meteorology.

The extension of physical and chemical knowledge, which I have here represented in separate notices, could not remain without its influence upon the earliest study of geology and geography. A great portion of the *geognostic* questions, with the solution of which our age is employed, were raised by a man of the most comprehensive genius, the great Danish anatomist, Nicholas Steno (Stenson) called to the service of Ferdinand II., the grand Duke of Tuscany; by another physician, an Englishman, Martin Lister; and by Robert Hooke, "a worthy rival (392) of Newton." I have treated in another work (393) more circumstantially of Steno's great merit in establishing the knowledge of geological stratification, or the position of the rocks. Certainly Leonardo da Vinci, about the end of the fifteenth century, probably whilst he was making the canal in Lombardy, which cuts through sedimentary strata and tertiary formations, became acquainted with the remaining traces of the previously existing generation of marine animals: so did also Fracastoro in 1517, when he had an accidental opportunity of examining the exposed strata in Monte Bolca at Verona, which are so rich in fossil remains of fish, and Bernard Palissy in

1563, in his investigations respecting the origin of springs. Leonardo, as it were in anticipation of a philosophical distribution of animal forms, calls the Conchylia "*animali che hanno l'ossa di fuori.*" Steno in his work 'Upon the contents of Rocks,' (*de Solido intra Solidum naturaliter contento*), published in 1669, distinguishes between "the strata (primary?) of rocks which became hard and solid before there were any plants or animals, and therefore contain no organic remains, from the sedimentary layers (*turbidi maris sedimenta sibi invicem imposita*), which alternate with one another, and lie over the former rocks. All the deposited strata containing petrefactions were originally found in a horizontal position. Their inclination originated partly from the eruption of subterranean vapours, produced by the central heat (*ignis in medio terræ*), and partly by the giving way of some weak subjacent strata which before supported them (394). The valleys are in result of this overthrow."

Steno's theory of the formation of valleys is the same as that of Deluc, whilst Leonardo da Vinci (395), with Cuvier, attributed their existence to the course of rivers. In describing the geological structure of the soil of Tuscany, Steno recognises revolutions which must be divided out into six great natural epochs, (*sex sunt distinctæ Etruriæ facies, ex præsenti facie Etruriæ collectæ*). The sea was thought to have broken in six times, and after remaining a long time in the interior of the country, to have again subsided within its original boundaries. But all petrefactions do not belong to the sea: Steno distinguishes between the sea-water and fresh-water fossils. Scilla published in 1670 delineations of the petrefactions at

Calabria and Malta. Among the latter, our great anatomist and zoologist, Johannes Müller, discovered the most ancient picture of the teeth of a gigantic Hydrarchus (the *Zeuglodon cetoides* of Owen) of Alabama, one of the species of the order 'Cetacea' of the Mammalia ([396]); the crowns of these teeth resemble those of the seal.

Lister started, as early as 1678, the important hypothesis that each kind of mountain is characterized by its own fossils, and that "the genera of Murex, Tellina and Trochus, which appear in the quarries of Northamptonshire, seem to be like those which are found at the present day in the sea, but upon close examination, they will be found to be different." He says, they are specifically different([397]). A stricter proof of the correctness of these grand anticipations in the imperfect condition of descriptive morphology at that time could not have been given. We here indicate an early glimmering of the light, soon again to be extinguished, which anticipated the splendid paleontological labours of Cuvier and Alexander Brongniart, and which gave a new form to the geology of the sedimentary formations([398]). Lister, directing his attention to the regularity of the successive stratified rocks in England, early felt the want of geological charts. Although these phenomena and their connection with the ancient floods, (whether occurring many times, or only once) attracted their attention, and by the admixture of faith and science gave rise to the so-called systems of Ray, Woodward, Burnet and Whiston in England; yet, as they were entirely without any mineralogical distinctions with regard to the constituents of compound rocks, everything referring to crystalline and non-crystalline eruptive

rocks and their metamorphosis was quite neglected. Notwithstanding the increase in the central heat of the globe of the earth, earthquakes, hot springs and volcanic eruptions were not looked upon as a result of the reaction of the interior of the planet against its outermost crust, but they were attributed to insignificant local causes; for example, to the spontaneous ignition of sulphureous deposits. Trifling experiments, made by Lemery in 1700, were unfortunately of very long-continued influence upon the theories of volcanos, although the latter might have been elevated to the dignity of general views by the imaginative *Protogæa* of Leibnitz, which appeared in 1680.

The *Protogæa*, occasionally more poetical than many of the metrical attempts of the same philosopher ([390]), which have lately become known, teaches "the incineration of the cavernous glowing crust of the earth, which was at one time independently luminous—the gradual cooling of the surface enveloped in mists, by the radiation of the heat—the precipitation and condensation of the gradually cooling atmospheric vapour to the condition of water—the sinking of the ocean by the penetration of the water into cavities in the centre of the earth—lastly, the falling in of these caverns, which gave rise to the sloping position of the strata, namely, their inclination with respect to the horizon." The physical portion of this wild and imaginative picture presents some traits which cannot be altogether rejected by the supporters of the new system of geology, which is so much more extensively developed on every side. To these belong the movement of the heat in the centre

of the earth, and the cooling by radiation from its surface; the existence of an atmospheric vapour; the pressure exerted by this atmosphere upon the strata as they are becoming consolidated, and the double origin of the masses of rock, namely, by fusion and subsequent hardening, or by precipitation from water. The typical characteristics and the mineralogical differences between* the kinds of mountains, that is, the repeated associations of certain substances, principally of a crystalline nature, in the most distant regions, are as little alluded to in the *Protogæa*, as in Hooke's geological views. In the works of the latter, physical speculations respecting the effects of subterraneous powers in earthquakes, in the sudden elevation of the bottom of the sea and the coasts, in the appearance of islands and mountains, are principally treated of. The nature of the organic remains of the former world led him to the supposition that the temperate zone must have at one time enjoyed the heat of a tropical climate.

It now remains for us to notice the greatest of all geological phenomena, namely, the mathematical form of the earth, in which the conditions of primitive times are plainly perceptible, namely, the former fluidity of the revolving mass and its solidification into the spherical form of the earth. A picture of the form of the earth, in its principal characters, but certainly not in the numerical relations of the polar to the equatorial axis, was sketched at the end of the seventeenth century. Picard's measurement of degrees, made in 1670, with instruments for the purpose, which he had himself constructed and completed, is so much more important

because it induced Newton to take up again, with renewed zeal, his theory of gravitation, which he had invented in 1666, and which he had afterwards neglected, and because it presented to this acute and fortunate inquirer the means of proving how the earth keeps the moon, which revolves by the centrifugal power, in her proper orbit. The flattening of the surface of the planet Jupiter, which was much earlier known(400), roused Newton, as it is supposed, to explore the cause of such an appearance of departure from the spherical shape. The experiments upon the true length of the pendulum for seconds, made at Cayenne by Richer in 1673, and on the western coast of Africa by Varin, anticipated those which were made in London, Lyons and Bologna (401) at a distance of seven degrees of latitude, and were more decisive. The decrease in weight from the pole towards the equator, which was for a long time denied even by Picard, was now generally assumed. Newton recognized the polar flattening of the earth and its spheroidal form to be a result of its rotatory movement; he even ventured to determine numerically the measurement of the difference in the earth's axes by assuming the mass to be homogeneous. It was left for the comparative measurement of degrees, made in the eighteenth and nineteenth centuries, below the equator, near the north pole, and in the temperate zones, both of the northern and southern hemispheres, to determine precisely the amount of the difference in the diameter, and the exact form of the earth. The existence of the flattening at the poles, is a proof, as I have already remarked in the *Picture of Nature*(402), of that which may be called the

most ancient of all geological occurrences, namely, the previous general fluid condition of the planet, and its subsequent solidification.

We commenced the delineation of the great age of Galileo and Kepler, Newton and Leibnitz, with the discoveries in the heavens, through the instrumentality of the newly-invented telescope. We terminate with the form of the earth, as it has been proved by theoretical conclusion. "Newton raised himself to the object of explaining the system of the universe, because he was fortunate enough to discover the power ([403]), of which the laws laid down by Kepler are a necessary consequence, and which must correspond to the phenomena, since these laws correspond to them, and have previously declared them." The discovery of such a power, the existence of which Newton developed in his immortal work, the *Principia*, (a general history of Nature), was almost simultaneous with the new road that was opened for mathematical research by the discovery of the infinitesimal method of calculation. The work of the intellect is chiefly visible in all its elevated grandeur, when, in lieu of requiring external and physical materials for its exercise, it obtains its splendour only from what springs from the mathematical development of thought, or from pure abstraction. There dwells an internal and comprehensive charm, celebrated by all antiquity ([404]), in the contemplation of mathematical truths, and in the everlasting relations of time and space, as they manifest themselves in accents, numbers and lines. The perfection of an intellectual instrument of inquiry, namely, the analysis, has powerfully promoted the mutual growth of ideas, an object of equal

importance with their first production. In the terrestrial and celestial spheres of the universe, it has exposed new districts of immeasurable extent to our physical survey, in the periodical fluctuations of the surface of the ocean, and in the changing disturbances of the planets.

VIII.—RETROSPECT OF THE SUCCESSIVE PERIODS THAT HAVE BEEN DESCRIBED—THE INFLUENCE OF EXTERNAL EVENTS UPON THE DEVELOPMENT OF A KNOWLEDGE OF THE UNIVERSE—MULTIPLICITY AND INTIMATE CONNECTION OF THE SCIENTIFIC ACHIEVEMENTS IN THE MOST MODERN TIMES—THE HISTORY OF THE PHYSICAL SCIENCES GRADUALLY UNITES WITH THE HISTORY OF THE CREATION.

I AM approaching the end of my daring and comprehensive undertaking. We have passed through more than two thousand years, from the earliest conditions of civilization among the races inhabiting the basin of the Mediterranean, and the fruitful river-country of Western Asia, to the beginning of the last century, and, therefore, to the time when the views and feelings of mankind were becoming identical with our own. I have attempted to represent, in seven separate and definite parts, and therefore, in the same number of distinct and successive pictures, the *History of a physical Contemplation of the World*, that is, the history of a gradually developed acquaintance with the universe. Whether I have at all succeeded

in grasping the vast mass of materials which have been collected together, in comprehending the characters of the principal epochs, and in pointing out the way by which ideas and habits have been formed, may not be decided by one, who rightly mistrusts the powers which remain to him, and before whose soul the plan of so vast an undertaking, is only clearly seen in its general outline.

In the beginning of my delineation of the Arabian epoch, when I commenced the description of the mighty influence exerted upon the civilization of Europe by the admixture of a strange element, I laid down the limits upon the other side of which the history of Kosmos coincides with that of the physical sciences. An historical acquaintance with the gradual development of natural science in the two spheres of Geography and Astronomy, is, according to my ideas, connected with certain periods, and with certain events, which borrow a peculiarity and colouring from the periods, and which have a physical and intellectual effect. Among these events were the following undertakings:—The voyages into the Euxine, and the first suspicion of the existence of another sea-shore upon the other side of Phasis:—the expedition to the tropical gold and spice countries:—the navigation through the Western Straits, and the discovery of the great maritime routes by which, at long intervals, Cerne and the Hesperides, the northern tin and amber countries, the volcanic Azores, and the new continent of Columbus, to the south of the ancient Scandinavian settlements, first became known. After the movements which commenced at the basin of the Mediterranean Sea, and the northern

extremity of the Arabian Gulf, and after the voyage to the Euxine and Ophir, the campaign of the Macedonian general, and his endeavour to amalgamate the east with the west, follow in my historical representations: then, the results of Indian trade, and the institutions at Alexandria, in the time of the Lagides; the Roman empire in the time of the Cæsars; the important desire among the Arab races to have intercourse with Nature and her powers, and to study astronomy, mathematics, and practical chemistry. At the time when man took possession of an entire hemisphere, which had been before concealed, and at the date of the greatest discoveries, in point of space, which it was ever his fortune to make, the succession of events which suddenly extended the range of ideas, stimulated inquiry into physical laws, and gave origin to a definite desire to arrive at a complete knowledge of the universe, comes to its termination. The intellect, thenceforward, as I have already pointed out, produces grand results, by its own peculiar and internal power, in every direction at the same time, without being incited thereto by any external occurrences.

Among the instruments, or new organs which man has acquired, and which heighten his powers of sensory perception, one has had almost the same effect as the sudden occurrence of some grand event. By means of the property of the telescope, to penetrate into distant space, a considerable portion of the heavens was, as it were, at once explored, the number of known heavenly bodies was increased, and an attempt made to determine their form and course. Mankind then attained, for the first time, possession of the "heavenly sphere," of the Creation. A

seventh section of the History of a Survey of the World has been founded upon the importance of this addition to our knowledge, and upon the singleness of the attempts which gave rise to the discovery of the telescope. We may compare the discovery of this optical instrument with another grand and more recent one, that of the voltaic pile, and the influence exerted by it upon the ingenious electro-chemical theory, on the proof of the existence of metallic bases to the alkalis and earths, and upon the long-wished for discovery of electro-magnetism; in this way, we arrive at a power of connecting the experiments which penetrate deeply into the knowledge of Nature's powers, but which rather form a section in the history of the physical sciences themselves, than in the history of a scientific idea of the universe. This manifold union of all our present knowledge renders it more difficult to separate and assign limits to each particular branch. We have recently seen electro-magnetism even produce an effect upon the direction of a ray of polarized light, giving rise to modifications similar to the results of chemical union. Where everything appears to be understood in its essence, in consequence of the mental exertion of a century, it is as dangerous to encroach upon the intellectual powers, and to represent that which is incessantly advancing, as having reached the goal, as with the consciousness of one's own limited knowledge, to pronounce an opinion upon the relative importance of the undertakings of renowned cotemporaries, or those who have but recently passed away.

In my historical considerations, whilst describing the early germs of natural science, I have generally marked

out the degree of development which it has attained in recent times. The third and last part of my work furnishes the results of observation upon which the present state of our scientific opinions are principally founded, to illustrate the general picture of Nature. Much that may have been missed in this part by one who has ideas respecting the composition of a *Book of Nature* different from my own, will be found in its place there. Excited by the splendour of new discoveries, elated by hopes which are frequently not proved to be fallacious until after the lapse of some time, each age presumes that it has come near to the highest point in the knowledge and understanding of Nature. I doubt whether, upon deeper thought, such a belief really adds to the enjoyment of the present. The conviction that the knowledge which has been obtained is only a very unimportant part of what the progressing activity and free education of mankind in future centuries will arrive at, is much more cheering and much more in accordance with our ideas of the grand destinies of our race. Every thing that is searched into and discovered is merely a step to something higher in the successive course of things.

The principal advance made in knowledge in the nineteenth century, which has formed the chief characteristic of the age, is a general and a successful endeavour not to limit the view solely to new discoveries, but strictly to prove, by measure and weight, every thing which has been touched upon in earlier times, to separate the conclusions from mere analogy, from that which is certain, and to subject all parts of science, physical astronomy, the study of the terrestrial powers of Nature, geology,

and antiquity to the same severe and critical method. The critical proceeding is so general, that it has aided in making known the limits of the separate sciences, and of discovering the weakness of certain doctrines in which unfounded opinions appear as matter of fact, and symbolical fables as strict and accurate theories. An indefinite phraseology and the transference of the nomenclature from one science to another, have given rise to false views and to deceptive analogies. Zoology has for a long time been impeded in its progress, because it has always been supposed that among the lower animals all vital functions were connected with highly complex organs, similar to those in the highest classes of animals. Still more has the study of the development of plants among the so-called cryptogamic Cormophytæ, as in the leaf-moss, the liverwort, the ferns, or the Lycopodiaceæ, or in the still lower Thallophytæ (Algæ, Lichens, Fungi), been obscured, because inquirers always believed that they found analogies with the reproductive organs in the animal kingdom ([105]).

When art exists within the magic circle of the imagination, or really within the mind, the extension of knowledge on the other hand, is found to depend especially upon contact with the external world. It becomes more manifold, and at the same time more real, with the increase of communication between nations. The attainment of new organs (instruments of observation) increases the intellectual, and frequently also the physical power of man. Thoughts and wishes are hurried along into the great distance by means of the electric stream. Powers, whose quiet working is seen in formation of the tender

cells of organic tissues, and in inorganic nature, and which are unappreciable to our senses, are acknowledged, used, and excited to higher activity; they appear among the unlimited succession of means which bring us nearer to the attainment of a complete command over certain distinct spheres of natural science, and to a more lively acquaintance with the structure of the universe.

NOTES.

[1] (p. 130.)—Kosmos, vol. i. p. 51—58.

[2] (p. 137.)—Niebuhr, Roman History, Pt. i. p. 69; Droysen, History of the Civilization of the Grecian States, 1843, p. 31—34, 567—573; Fried. Cramer de studiis quæ veteres ad aliarum gentium contulerint linguas, 1844, p. 2—13.

[3] (p. 138.)—In Sanscrit ice is *vrîhi*, coltar, *karpâsa*, sugar *'sarkara*, spikenard, *nanartha; vide* Lassen's Indian Antiquity, vol. i. 1843, p. 245, 250, 270, 289 and 538. Respecting *'sarkara* and *kanda*, whence our word sugar-candy is derived; *vide*, my Prolegomena de distributione geographica plantarum 1817, p. 211; "Confudisse videntur veteres saccharum verum cum Tebaschiro Bambusæ, tum quia utraque in arundinibus inveniuntur, tum etiam quia vox sanscradana *scharkara*, quæ hodie (ut pers. *schakar* et hindost. *Schukur*) pro saccharo nostro adhibetur, observante Boppio, ex auctoritate Amarasinhæ, proprie nil dulce (*madu*) significat, set quicquid lapidosum et arenaceum est, ac vel calculum vesicæ. Verisimile igitur, vocem *scharkara* initio duntaxat tebaschirum (*saccar mambu*) indicasse posterius in saccharum nostrum humilioris arundinis (*ikschu, kandekschu, kanda*) ex similitudine aspectus translatam esse. Vox Bambusæ ex *mambu* derivatur; ex kanda nostratium voces, *candis*, zuckerkand (anglice, sugar-candy). In *tebaschiro* agnoscitur Persarum *schir*, i. e. lac, sanscr. *kschiram*." The Sanscrit name for *tabaschir* is (Lassen, vol. i. p. 271—274), *tvakkschîrâ*, cow's milk. Milk from the cow (*tvatsch*). Compare also, Pott, "Kurdish Studies in the Journal of Eastern Knowledge," vol. vii. p. 163—166, and the masterly Treatise of Carl Ritter, in his Geography of Asia, vol. vi. 2. p. 232—237.

[4] (p. 141.)—Ewald, History of the Israelites, vol. i. 1843, p. 332—334. Lassen's Indian Antiquity, vol. i. p. 528. Compare Rödiger in the Journal for Eastern Knowledge, vol. iii. p. 4, upon the Chaldeans and Kurds; the latter are called Kyrtians by Strabo.

[5] (p. 141.)—Bordj, the centre of Ormuzd, about in the place where the Celestial Mountain (Thian-schan) by its western extremity, passes into the mountains of Bolor (Belurtagh), or rather continues the latter, under the name of the Asferah Chain, north of the highland of Pamer, (Upa-Mêru, the land above the Meru.) Compare Burnouf, Commentaire sur le Yaçna vol. i. p. 239, and the appendix p. clxxxv. with Humboldt, Asie Centrale, vol. i. p. 163, vol. ii. p. 16, 377, and 390.

[6] (p. 141.)—Chronological data for Egypt; "3900 years before Christ, Menes (at least, and this is probably nearly correct); 3430, the beginning of the 4th dynasty (the builders of the Pyramids, Chephren-Schafra, Cheops-Chufu, and Mykerinos or Menkera); 2200 the termination of the Hyksus under the 12th dynastry, to which Amenemha III., the builder of the original labyrinth, belonged. Before Menes (B.C. 3900), we must allow at least a thousand years, and probably much more, for the gradual growth of that degree of civilization which was complete and even formal, as much as 3430 years before our era. (Lepsius, in many letters addressed to me, in March 1846, and after his return from his celebrated expedition). Compare also Bunsen's Treatise "Concerning the beginning of our so-called history of the world, which, strictly considered, is only that of the modern races, or if there must be a history of these beginnings, it is the modern history of the human race," in the talented and learned work, "Egypt's place in the history of the world, 1845, book i. p. 11—13. The historical knowledge and regular chronology of the Chinese ascends as far back as 2400, or even 2700 years before our era, far beyond Ju to Hoang-ty. Many literary monuments of the date of the 13th century exist in China; and in the 12th century, B.C., according to the Tscheu-li, the length of the Solstitial shadow had been already measured by Tscheu-kung, in the city Lo-yang, built to the south of the Yellow River, with such accuracy, that Laplace found that it completely corresponded with the theory of the change in the obliquity of the elliptic, which was first established at the end of the last century. Every suspicion that they fabricated this position, and calculated backwards, falls to the ground at once. *Vide* Edward Biot, sur la Constitution politique de la Chine, au 12me siècle avant notre ère, (1845) p. 3 and 9.

The building of Tyre, and of the ancient temples of Melkarth (the Tyrian Hercules), according to the account which Herodotus received (ii. 44), from the priests, reaches as far as 2760 years before our era; compare also, Heeren, Ideas respecting the political constitution and intercourse of races, Pt. i. 2. 1824, p. 12. Simplicius, according to a tradition of Porphyry, considers the age of the Babylonian astronomical observations, which were known to Aristotle, as having been 1903 years before Alexander the Great, and Ideler, who is so deep and careful an inquirer into chronology, considered this estimate as by no means improbable; compare his Manual of Chronology, vol. i. p. 207, the treatises of the Berlin Academy of the year 1814, p. 217, and Böckh. Metrol. inquiries respecting the Measures of Antiquity, 1838, p. 36. It is still very doubtful whether an historical basis is to be found in India more than 1200 years B.C. even according to the Chronology of Kashmir (Radjatarangini, trad. par Troyer), whilst Megasthenes (Indica, edit. Schwanbeck, 1846, p. 50,) reckons from Manu to Kandragupta, for 153 kings of the dynasty of Magadha, 60 to 64 centuries, and the Astronomer Aryabhatta determines the beginning of the calculation of the time at 3102 years B.C., (Lassen's Indian Antiquity, vol. i. p. 473, 505, 507, and 510). In order to give the numbers which are placed side by side in this note a more intelligible signification for the history of human civilization, it is not superfluous to record here, that among the Greeks, the destruction of Troy is placed at 1184 years before our era; Homer, 1000 or 950; Cadmus the Milesian, the first historian among the Greeks, 524 years B.C. This comparison of epochs teaches us how unequal in point of time, (whether earlier or later,) the necessity of accurately reckoning the dates of certain events and undertakings was awakened in the people who were most capable of civilization. It reminds us involuntarily of an expressions which Plato in the Timæus places in the mouths of the priests of Sais: "O Solon! Solon! ye Greeks still remain children; nowhere in Greece is there an old man. Your souls are always youthful. Ye have in you no knowledge of antiquity, no ancient faith, and no wisdom which has grown grey by time."

7 (p. 142.)—Compare Kosmos, vol. i. p. 94 and 163.

8 (p. 142.)—William v. Humboldt upon an Episode of the Maha-Bharata, in his Entire Works, vol. i. p. 73.

9 (p. 145.)—Kosmos, vol. i. p. 314 and 357; Asie Centrale, vol. iii. p. 24 and 143.

10 (p. 146.)—Plato, Phædon, p. 109 B. (compare Herodotus ii. 21).

Also Cleomedes imagined that the surface of the earth is hollowed out in the middle, in order to be able to hold the Mediterranean. Voss (Critical Leaves) vol. ii., 1828, p. 144 and 150).

[11] (p. 147.)—I first developed this idea in my Relat. historique du Voyage aux Regions équinoxiales, vol. iii. p. 236, and in my Examen critic. de l'hist. de la Géographie au 15me Siècle, vol. i. p. 36—38. Compare also the papers by Otfried Müller in the "Göttingen Literary Notices" of the year 1838, vol. i. p. 375. The western basin, which I generally call the Tyrrhenian, includes, according to Strabo, the Iberian, Ligurian and Sardoan Seas. The basin of the Syrtes, east of Sicily, includes the Ausonian or Sicilian, the Libyan and Ionian Seas. The south and south-west part of the Ægean Sea is called the Cretan, Saronian and Myrtoan Sea. The remarkable passage in Aristotle, *de Mundo*, cap. 3, (p. 393 Bekk.) alludes merely to the bays upon the shores of the Mediterranean and their influence upon the ocean pouring into them.

[12] (p. 147.)—Kosmos, vol. i. p. 256—449.

[13] (p. 148.)—Humboldt, Asie centrale, vol i. p. 67. The two remarkable passages of Strabo are the following, (lib. ii. p. 109): "Eratosthenes mentions three, and Polybius five projecting points of land in which Europe terminates. The former alludes, first, to that which stretches out opposite the Pillars of Hercules, upon which Iberia is situated; then follows the Sicilian Strait where Italy is; and the third peninsula is at Malea, including all the nations between the Adriatic, the Euxine, and the Tanais." (Lib. ii. p. 126): "We begin with Europe because *its form is so varied*, and it is the portion of the earth which has been of most service in elevating men and in founding cities. It is altogether habitable, except a small part near the Tanais, which is uninhabitable on account of the cold."

[14] (p. 149.)—Ukert, Geography of the Greeks and Romans, Pt. i. sect. 2, p. 345—348, and Pt. ii. sect. 1, p. 194; Johannes von Müller's Works, vol. i. p. 38; Humboldt, Examen critique, vol. i. p. 112 and 171. Otfried Müller's Minyans, p. 64, and also a very favourable review of my treatise upon the Mythical Geography of the Greeks, by this author in the Göttingen Literary Notices, 1838, vol. i. p. 372 and 383. I expressed myself generally to this effect: "En soulevant des questions qui offriraient déjà de l'importance dans l'intérêt des études philologiques, je n'ai pu gagner sur moi de passer entièrement sous silence ce qui appartient moins à la description du monde réel qu'au cycle de la Géographie

mythique. Il en est de l'espace comme du tems: on ne saurait traiter l'histoire sous un point de vue philosophique, en ensevelissant dans un oubli absolu les temps héroïques. Les mythes des peuples, mêlés à l'histoire et à la géographie, ne sont pas *en entier du domaine du monde idéal.* Si le vague est un de leurs traits distinctifs, si le symbole y couvre la réalité d'un voile plus ou moins épais, les mythes intimement liés entre eux, n'en révèlent pas moins la souche antique des premiers aperçus de cosmographie et de physique. Les faits de l'histoire et de la géographie primitives ne sont pas seulement d'ingénieuses fictions, les opinions qu'on s'est formées sur le monde réel, s'y reflètent." My friend, the great investigator of antiquities, whose early loss upon the soil of Greece, which he had so deeply and variously explored, is greatly lamented, thought, on the contrary, that the great interest in the poetical beauties of the earth apparent in the poetry of the Greeks, is by no means to be ascribed to real experience; from their disposition to wonder and their credulity, their ideas preserved a fabulous form (as is especially represented with respect to the traditions of the Phœnician sailors); the true origins of these pictures lay in certain ideal pre-conceptions and imaginings, upon which a real knowledge of geography gradually began to work in after-time; hence the interesting phenomenon frequently results, that the purely subjective creations of a fancy, led on by certain ideas, imperceptibly passes into the real study of countries and the well-known objects of scientific geography. According to these considerations, we may conclude that all pictures of the fancy which are mythical, or which take on a mythical form, in their real origin, belong to the world of ideas, and had at first really nothing whatever to do with the actual extension of geographical knowledge, or of navigation outside the Pillars of Hercules. The opinion which I expressed in my French work coincides more nearly with the earlier views of Otfried Müller, for in his *Prolegomena to a Scientific Mythology*, p. 68 and 109, he says very distinctly, "that in mythical narratives, that which occurs and that which is imagined, or the real and the ideal world, are generally very closely connected together." (Compare also, concerning Altas and Lyctonia, Martin's Etudes sur le Timée de Platon, vol. i. p. 293—326).

15 (p. 149.)—Naxos by Ernest Curtius (1846), p. 11; Droysen's History of the Civilization of the Grecian States, 1843, p. 4—9.

16 (p. 150.)—Leopold v. Buch, upon the Geognostic System of Germany, p. xi.; Humboldt's Asia centrale, vol. i. p. 284—286.

[17] (p. 151)—Kosmos, vol. i. p. 470.

[18] (p. 152.)—All that refers to Egyptian Chronology and History, and that is marked in the text by inverted commas (p. 152—155) is founded upon some manuscript communications made to me in the month of March, 1846, by my friend Professor Lepsius.

[19] (p. 152.)—With Otfried Müller (Dorier, Pt. ii. p. 436) I put the Dorian immigration into the Peloponnesus at the date 328 years before the first Olympiad.

[20] (p. 152.)—Tacit. Annal. ii. 59. In the Papyrus of Sallier (Campagnes de Sésostris) Champollion found the names of Javanen or Jonni, and that of Luki (Ionians and Lycians ?) Compare Bunsen's Egyptians, book i. p. 60.

[21] (p. 154.)—Herod. ii. 102 and 103; Diodor. Sicul. i. 55 and 56. Of the pillars (*Stelen*), which Ramses-Miamun placed as memorials of victory in the lands which he passed through, Herodotus, (ii. 106), names expressly three; " one in Syria of Palestine, two in Ionia, in going from Ephesus to Phocæa, and from Sardes to Smyrna." A relief cut upon the rock which contains the name of Ramses several times repeated, was found in Syria at Lycus (our Beyrout:—Berytus), as well as another ruder one in the valley of Carabel at Nymphio, according to Lepsius, in the way from Ephesus to Phocæa, (Lepsius in the Annals of the Archæological Institute, vol. x., 1838, p. 12, and also in his letter from Smyrna of December, 1845, in the Archæological Journal, May, 1846 No. 41, p. 271—280; Kiepert in the same journal, 1843, No. 3, p. 35). Whether the great conqueror, as Heeren believed, (History of the Ancient States, 1828, p. 76), arrived as far as Persia and further India, " because at that time Western Asia contained no great kingdom," (the building of Nineveh of the Assyrians took place 1230 years B.C.) will soon be determined by the rapid progress made in these discoveries by the archæologists and inquirers into Phonetic languages. Strabo (lib. xvi. p. 760) mentions a monument of Sesostris, near to the Straits of Deira, now called Bab-el-Mandeb. It is, moreover, very probable that in the *Ancient Kingdom*, more than 900 years before Ramses-Miamun, similar campaigns of the Egyptian kings into Asia took place. In the time of Pharaoh Setos II., belonging to the 19th dynasty, and the second successor of Ramses-Miamun, Moses went out of Egypt, according to the investigations of Lepsius, about 1300 years before our era.

[22] (p. 154.)—According to Aristotle, Strabo and Pliny, but not accord-

ing to Herodotus; *vide* Letronne in the Revue des deux Mondes, 1841, vol. xxvii. p. 219; and Droysen's Civilization of the Grecian States. p. 735.

[23] (p. 154.)—To the important opinions of Rennell, Heeren, and Sprengel, in favour of the circumnavigation of Libya, we must also now add that of a very deep philologist, Etienne Quatremère, (*Vide* Mém. de l'Acad. des Inscriptions, vol. xv. Pt. 2, 1845, p. 380—388). The most convincing argument for the truth of Herodotus' report, (iv. 42), appears to be the wonderful remark which he makes, that in sailing round Libya, from east to west, they had the sun upon their right. In the Mediterranean, by sailing from east to west, (from Tyre to Gadeira), the sun could only be seen to their left. At any rate, before the time of Neku II. (Necho), an ancient knowledge of the possibility of an uninterrupted voyage round Libya must have existed, since Herodotus decidedly makes Neku command the Phœnicians "that they must return to Egypt through the Pillars of Hercules." It is very wonderful that Strabo (lib. ii. p. 98), who discusses so much at length the attempt of Eudoxus of Cyzicus to sail round in the time of Cleopatra, and even mentions the wreck of a ship of Gadeira found upon the (eastern) Ethiopian shores should explain the previous real voyages round Libya as a Bergean fable, (lib. ii. p. 100), but he by no means denies the possibility of such a voyage, (lib. i. p. 38), and it is also remarkable that he supposes there is, to the east and west, but little of what had not been sailed round (lib. i. p. 4.) Strabo did not uphold the wonderful hypothesis respecting the isthmus of Hipparchus and Marinus Tyrius, according to which the east of Africa is united to the south-east extremity of Asia, and makes the Indian Ocean an inland sea, (Humboldt, Examen crit. de l'Histoire de la Géographie, vol. i. p. 139—142, 145, 161 and 229, vol. ii. p. 370—373). Strabo cites Herodotus, but does not mention the name of Neko, whose expedition he confounds with the circumnavigation of southern Persia and all Arabia, set on foot by Darius, (Herod. iv. 44). Gosselin very rashly wished to change the reading of Darius into Neko. A counterpart to the image of the horse, the figure-head of a ship of Gadeira, which Eudoxus is said to have exhibited in a market-place in Egypt, exists in the account of the wreck of a ship in the Red Sea, which according to the narrative of a very credible Arabian historian, (Masudi, in the Morudj-al-jeheb, Quatremère, p. 389, and Reinaud, Relation des voyages dans l'Inde, 1845, vol. i. p. xvi, and

vol. ii. p. 46), was brought to the coast of Crete by currents from the west.

[24] (p. 155.)—Diod. lib. i. cap. 67, 10; Herod. ii. 154, 178 and 182. Respecting the probability of intercourse between Egypt and Greece before the time of Psammetichus, *vide* the acute remarks of Ludwig Ross in the Hellenica, vol. i. 1846, p. v. and x. "In the times immediately before Psammetichus (says he) there was, in both countries, a period of internal disturbance, which necessarily must produce a limitation and partial interruption to commercial intercourse."

[25] (p. 156.)—Böckh, Meteorological Inquiries respecting the Weights, Coins and Measures of Antiquities, with respect to their connection, 1838, p. 12 and 273.

[26] (p. 156.)—*Vide* the passages collected in Otfried Müller's Minyans, p. 115, and the Dorians, Pt. i. p. 129; Franz. Elementa Epigraphices Græcæ, 1840, p. 13, 32 and 34.

[27] (p. 157.)—Lepsius, in his Treatise upon the Order and Relationship of the Semitic, Indian, Ancient Persian, Ancient Egyptian and Ethiopian Alphabets, 1836, p. 23—28 and 57. Gesenius, Scripturæ Phœniciæ Monumenta, 1837, p. 17.

[28] p. 158.)—Strabo, lib. xvi. p, 757.

[29] (p. 158.) It is easier to determine the Tin countries (Britain, and the Scilly Islands) than the Amber coasts: for it seems to me improbable that the ancient Grecian name, κασσίτερος, already known in the Homeric times, is derived from a mountain, Cassius, containing plenty of tin, in the south-west of Spain, to which Avienus, who is well acquainted with this region between Gadira and the mouth of the little river, Iberus, transferred it, (Ukert, Geography of the Greeks and Romans, Pt. ii. section i. p. 479.) *Kassiteros* is the old Indian Sanscrit word *Kastîra*, tin; (in German, and the language of Iceland and Denmark, *zinn*, in Swedish, *tenn*) is called in the Malay and Javanese languages, *timah*, a resemblance of sounds, which almost reminds us of the similarity between the ancient German word, *glessum* (the name for transparent amber) and our modern German word, *glas*, (glass). The names of wares and commodities for trade (*vide* above, p. 138, note 3) pass from one people to another, using entirely different families of languages. By the intercourse carried on by the Phœnicians from their factories in the Persian Gulf, with the eastern coast of India, the Sanscrit word,

kastîra, which means so useful a product of Further-India, and is even now found among the old Aramæic idioms in Arabia, as *kasdir*, might have become known to the Greeks, even before Albion and the British Cassiterides had been visited. (Aug. Wilh. von Schlegel in the Indian Library, vol. ii. p. 393, Benfey's India, p. 307; Pott, Etymological Inquiries, Pt. ii. p. 414: Lassen's India Antiquities, vol. i. p. 239.) A name is frequently a historical memorial, and the study of languages by examination of the etymology of their words, although despised by unlearned persons, bears its fruits. The ancients were acquainted with tin, one of the rarer metals upon the earth, in the land of the Artabri and the Callæci, upon the north-western continent of Iberia, and therefore in a much nearer country for a voyage from the Mediterranean than the Cassiterides (Æstrymnides of Avienus,) (Strabo, lib. iii. p. 147, Plin. xxxiv. c. 16.) When I was in Galicia, in the year 1799, before I sailed to the Canary Islands, there was in a granite mountain there, a very poor mine in work (*vide* my Relation hist. vol. i. p. 51 and 53.) This existence of tin is a matter of some geognostic importance on account of the former connection of Galicia with the peninsulas of Britany and Cornwall.

30 (p. 158.)—Etienne Quatremère, op. cit. p. 363—370.

31 (p. 158.)—The opinon which has been already expressed, (Heinzen's New Magazine, Pt. ii. 1787, p. 339; Sprengel, History of Geographical Discoveries, 1792, p. 51; Voss, Critical Leaves, vol. ii. p. 392—403), that amber was first obtained only from the western Cimbrian coasts, by means of voyages, and by inland trade upon the roads in the neighbourhood of the Mediterranean, gains more credit continually. The deepest and most acute examination of this circumstance is contained in Ukert's treatise upon Amber, in the Journal for Ancient Sciences, 1838, No. 52—55, p. 425, 452. (Compare with it, his Geography of the Greeks and Romans, Pt. ii. sect. 2, 1832, p. 26—36, Pt. iii. sect. 1, 1843, p. 86, 175, 182, 320 and 349.) The Massilians, who according to Heeren in the time of Pytheas, reached as far as the Baltic, after the Phœnicians scarcely got beyond the mouths of the Weser and Elbe. Pliny (iv. 16) places the amber island, Glessaria, (also called Austrania), certainly westward of the promontory of the Cimbri, in the German Ocean and the connection with the expedition of Germanicus teaches us sufficiently that an island in the Baltic was not meant. The great effects of ebbing and flowing in the '*æstuariis*' which throw up the amber, where,

according to the expression of Servius, "*mare vicissim tum accedit, tum recedit*," only allude to the coast between the Helder and the Cimbrian peninsula, and not to the shore of the Baltic, in which the island Baltia, mentioned in Timæus, is probably situated, (Plin. xxxvii. 2.) Abalus, one day's journey from the '*æstuarium*,' cannot therefore be the Curian trading place. Compare also respecting the voyage of Pytheas to the western coast of Jutland and the amber trade, along the whole shore of Skagen, as far as the Netherlands, Werlauff, *Bidrag til den nordiske Ravhandels Historie*, (Copenhagen, 1835.) It was not Pliny, but Tacitus' who first knew the *glessum* of the shores of the Baltic, in the lands of the Æstyans (*Æstuorum gentium*) and of the Venedi, respecting whom the great philologist, Schaffarik, is uncertain whether they are of Sclavonic or German origin, (*slawische Alterthümer*, Pt. i. p. 151—165.) The active and immediate intercourse with the coast of the Baltic and the Æstyans by the road across Pannonia through Carnuntum, made by a Roman knight in the time of Nero, appears to me to have been in the latest times of the Roman Emperors (Voigt's History of Prussia, vol. i. p. 85.) Some beautiful coins which have been recently found in the Netze district, and which were probably stamped before the 85th Olympiad, testify the communication between the coast of Prussia and the Grecian colonies on the Black Sea, (Levezow, in the Transactions of the Berlin Acad. of Science, of the year 1833, p. 181—224.) But at very different times and from very different regions, the amber (electron, the *Sun-stone* of the ancient fable of Eridanus) that was collected or dug up on the coasts (Pliny, xxxvii. cap. 2) was taken to the south by sea and by land. The amber "dug up in two places in Scythia, was in parts very dark-coloured." Certainly, at Kaltschedansk, not far from Kamensk, in the Ural Mountains, amber is collected at the present day; we have preserved fragments of it embedded in peat in Katherinenburg (*Vide* Rose, Journey to the Ural Regions, vol. i. p. 481, and Sir Roderick Murchison, in his Geology of Russia, vol. i. p. 366). The fossil wood which frequently enveloped the amber, attracted the attention of the ancients at an early date. The resin, which was formerly so precious, was at one time considered to come from the black poplar trees, (according to Scymnus of Chios, v. 396, p. 367, Letronne), and at another to a tree from the genus of the Cedars or Pine, (according to Mithridates, in Pliny, xxxvii. cap. 2 and 3). The most recent and excellent investigations of Professor Göppert, of Breslau, have taught us that the idea of the Roman

compiler was most correct. Compare also the account of a fossil amber tree *(Pinites succinifer)* of a departed vegetable world, Kosmos. vol. i. p, 303, and Berendt's Organic Remains in Amber, vol. i. sect. i. 1845. p. 89.

[32] (p. 159.)—*Vide* concerning the Chremetes (Aristot. Meteor. lib. i. p. 350, Bekk.) and of the Southern points, of which Hanno in the journal of his voyage makes mention, my Rel. historique, vol. i. p. 172, and Examen crit. de l'Histoire de la Géograph. vol. i. p. 39, 180 and 288, vol. iii. p. 135 (Gosselin, Recherches sur la Géogr. systém. des Anciens, vol. i. p. 94 and 98; Ukert, Pt. i. p. 61—66).

[33] (p. 159.)—Strabo, lib. xvii. p. 826. The destruction of the Phœnician colonies by the negroes (lib. ii. p. 131) seems to indicate a settlement very far to the south; more so, perhaps, than the region of the crocodiles and elephants, which Hanno mentions; since both were found, north of the desert of Sahara, in Maurusia and in the western country of the Atlas Mountains, as Strabo (lib. xvii. p. 827; Ælian de Nat. Anim. vii. 2; Plin. v. i.) shews, and as many events of the wars between Rome and Carthage indicate. (Compare respecting this important circumstance respecting the geographical distribution of animals, Cuvier, Ossemens fossiles, 2nd edition, vol. i. p. 74, and Quatremère, op. cit. p. 391—394).

[34] (p. 160.)—Herod. iii. 136.

[35] (p. 161.)—I have circumstantially treated of this much contested point, and of the passages of Diodorus (v. 19 and 20) and Pseudo-Aristotle (Mirab. Auscult. cap. 85, p. 172, Bekk.) in another place. (Examen. crit. vol. i. p. 130—139, vol. ii. p. 158 and 169, vol. iii. p. 137—140.) The compilation of the Mirab. Auscult. seems to be older than the first Punic War, for it delineates the Sardinians under the government of a deputy from Carthage. It is also remarkable that the wooded island mentioned in this work is described as being uninhabited, (and therefore of course not peopled by the Guanches). The Guanches inhabited the entire group of the Canaries; but in reality they did not inhabit the Island of Madeira, in which neither Johann Gonzalves and Tristan Vaz in 1519, nor yet Robert Masham with Anna Dorset, who were still earlier (provided their Robinson Crusoe history is true), found any inhabitants. Heeren refers the description of Diodorus to Madeira alone, but still in the works of Festus Avienus (v. 164) who was so well acquainted with the Punic writings, he believes that he can recognize an account of the frequent volcanic disturbances of the Peak of Teneriffe, (Ideas upon Politics and Trade, Pt. i. sect. i. 1826, p. 106). According

to the geographical relations, a northern region appears to me to be alluded to in the representations of Avienus, (Examen critique, vol. iii. p. 138), perhaps even in the Cronian Sea. The Punic sources of information, which Juba made use of, are also made use of by Ammianus Marcellinus, xxii. 15. Respecting the probability of the Semitic origin of the name of the Canary Islands (Pliny in his latinizing etymological notions considered them to be *Dog Islands!*) *vide* Credner's Biblical representation of Paradise in Illgen's Journal for Historical Theology, vol. vi. 1836, p. 166—186. The most fundamental, and, in a literary point of view, the most complete account of the Canary Islands, that was written in ancient times down to the Middle Ages, was collected in a work of Joachim José da Costa de Macedo, with the title: "Memoria em que se pretende provar que os Arabes não conhecerão as Canarias antes dos Portuguezes, 1844." If, besides traditions, history is silent as far as it is founded upon secure and firmly expressed testimony, then there only remain certain gradations of probability; an absolute denial of any fact in the history of the world, where the proof is uncertain, appears to me to be an unhappy application of philological and historical criticism. The numerous data which have come down to us from antiquity, and an acute examination of the local relations, especially the great vicinity of the settlements upon the African coast, which incontestibly existed, lead me to believe that Phœnicians, Carthaginians, Greeks and Romans, and probably even the Etruscans, were acquainted with the group of the Canary Islands.

[36] (p. 161.)—Compare the calculations in my Relat. Hist. vol. i. p. 140 and 287. The Peak of Teneriffe is distant 2° 49′ in a curve from the nearest point of the African coast. With the assumption of an average refraction of ·08 the summit of the peak may then be seen from a height of 202 toises, and therefore from the *Montanas negras*, not far from the Cape of Bojador. In this calculation the Peak is taken as 1904 toises above the level of the sea. Latterly, Captain Vidal found it to be 1940, in measuring it trigonometrically; MM. Coupvent and Dumoulin, with the barometer, made it 1900. (D'Urville, Voyage au Pole Sud, Hist. vol. i. 1842, p. 31 and 32). But Lancerote with a volcano 300 toises in height, la Corona (Leop. von Buch, *Canary Islands*, p. 104) and Fortaventura lie much nearer the coast than Teneriffe; the first of these islands is at a distance of 1° 15′, the second of 1° 2′.

[37] (p. 162.)—Ross mentions the supposition merely as a tradition in *Hellenica*, vol. i. p. xi. May not the observation have been altogether deceptive in its origin? If we take the height of Ætna above the level of the sea to be 1704 toises (in the latitude 37° 45′, the longitude 12° 41′ from Paris) and that of the point of observation on the Elias Hill of Taygetos at 1236 toises, (lat. 36° 57′, long. 20° 1′), and the distance to be 88 geographical miles, the height of the point to be reached by the light from Ætna in order to be seen from Taygetos must be full 7612 toises, and therefore 4½ times as high as Ætna. If, on the contrary, says my friend, Professor Encke, we may assume the reflection from some surface between Ætna and Taygetos, as for example, the reflection from a cloud which is distant 46 miles from Ætna, and 42 from Taygetos, the elevation of the reflecting surface need only be 286 toises.

[38] (p. 162.)—Strabo, lib. xvi. p. 767 Casaub. According to Polybius, the Euxine and the Adriatic can be seen from Mount Aimon; this opinion is scorned by Strabo (lib. vii. p. 313.) Compare Scymnus p. 93.

[39] (p. 163.)—Respecting the synonymes of Ophir, *vide* my Examen crit. de l'hist. de la Géogr. vol. ii. p. 42. Ptolemæus mentions (lib. vi. cap. vii. p. 156) Sapphara, metropolis of Arabia, and (lib. vii. cap. i. p. 168) Supara, in the Gulf of Camboya (Barigazenus sinus, according to Hesychius), "a region rich in gold!" Supara, in Indian language, means a beautiful shore. (Lassen, dis. de Tapobraue, p. 18, and Indian Antiquity, vol. i. p. 107; Keil, professor in Dorpat, upon the voyage of Solomon and Hiram to Ophir and Tarsis, p. 40—45.)

[40] (p. 163.)—Are ships of Tarsus, ocean ships? or do they obtain their name as Michæli observes, from the Phœnician Tarsus, in Cilicia? *Vide* Keil, p. 7, 15—22 and 71—84.

[41] (p. 163.)—Gesenius, Thesaurus linguæ Hebr. vol. i. p. 141, and in the Encyclop. of Ersch and Gruber, by the same author, sect. iii., pt. iv. p. 401.; Lassen's Indian Antiquity, vol. i. p. 538; Reinaud, Relation des Voyages faits par les Arabes dans l'Inde et en Chine, vol. i. 1845, p. xxviii. The learned author Quatremère, who, in a treatise recently published, (Mem. de l'Acad des Inscriptions), vol. xv. Pt. ii, 1845, p. 349—402, with Heeren, considers Ophir to be a part of the eastern coast of Africa, translates the word *thukkiim*, *thukkiyyim*, not to mean peacocks, but parrots, or guinea-fowls (p. 375). Respecting Socotora, compare Bohlen's Ancient India, Part ii. p. 139, with Benfey's India, p. 30—32.

Sofala is described by Edrisi (in Amédée, Jaubert's translation, vol. i. p. 67), and later, after Gama's Voyage of Discovery, by the Portuguese writers (Barros, Dec. i. lib. x., cap. i. Pt. ii, p. 375; Külb's History of Voyages of Discovery, Pt. i. 1841, p. 236), as a land rich in gold. I have, in another place, drawn attention to the fact, that Edrisi mentions, in the middle of the 12th century, the use of quicksilver in the gold-washing of the negroes, as of a method of making an amalgam which had been long known. If we keep in mind the frequent interchange of the letters *r* and *l*, we find that the name of the east African Sofala re-appears in the form of Sophara, which, in the translation of the Septuagint, and many other places, is the word used for the Ophir of Soliman and Hiram. Ptolemæus also, as I have above-mentioned, was acquainted with a Sapphara in Arabia (Note 39, Ritter's Asia, vol. viii. 1 1846, p. 252), and a Supara in India. As in the present relations between the parts of America where they speak Spanish, and where they speak English, so there the significant Sanscrit names prevalent in the mother country, were reflected to the neighbouring or opposite coasts. The scope of the trade from Ophir might, therefore, in my opinion, be as easily extended, as the voyages of the Phœnicians might reach from Tartessus to Cyrenæ and Carthage, Gadeira and Cerne, in a voyage to the Cassiterides, reach the Artabrian shores, or Britain, and the eastern coast of Cimbria. It is remarkable, that frankincense, spices, silk, and woollen articles, are not mentioned among the wares of Ophir, together with ivory, monkeys, and peacocks. The latter are exclusively Indian; although on account of their being gradually extended towards the west, they were called by the Greeks *Median* or *Persian* birds, and the Samians, from their being kept in the sanctuaries of the priests, considered them to have been originally of Samian origin. From a passage of Eustathius (Comm. in Iliad, vol. iv. p. 225, ed. Lips. 1827), respecting the sacred nature of the peacocks in Libya, an unfair conclusion has been drawn, that the ταώς belongs to Africa.

42 (p. 163.)—*Vide* Columbus upon Ophir, and *el Monte Sopora*, "which Solomon's fleet was enabled to reach in three years," in Navarette, *Viages y descubrimientos que hiciéron los Espanoles*, vol. i. p. 103. In another place, this great discoverer says, still hoping to reach Ophir, "The splendour and power of the gold of Ophir are indescribable; he who possesses it, does what he likes in this world; and it even enables him to draw souls out of purgatory into paradise (*llega á que echa las animas al*

paraiso.)" Carta del Almirante escrita en la Jamaica, 1503, (Navarrette, vol. i. p. 309). Compare my Examen critique, vol. i. p. 70 and 109; vol. ii. p. 38—44, and upon the real duration of the voyage of Tarshish, Keil, p. 106.

[43] (p. 163.)—Ctesiæ Cnidii Operum Reliquiæ, ed Felix Baehr, 1824, cap. iv. and xii. p. 248, 271, and 300. But the accounts of the physician at the Court of Persia, collected from native sources, and therefore not so doubtful, point to regions in the north of India, and from these the gold of the Daradas must have arrived by many circuitous paths, to Abhira, to the mouth of the Indus, and the coasts of Malabar; compare my *Asie Centrale*, vol. i. p. 157, and Lassen's Indian Antiquity, vol. i. p. 5. Ought we not to consider the wonderful statement of Ctesias, respecting the Indian source of the metal, in which they found iron of a very fusible nature, after the fluid gold has been melted away and removed, to be a misunderstood narrative of a foundry. The molten iron, on account of its colour, was considered to be gold, and when the yellow colour disappeared upon cooling, the black mass of iron was discovered.

[44] (p. 164.)—Aristotle's Mirab. Auscult, cap. 86 and 111, p. 175 and 225, Bekk.

[45] (p. 165.)—The Etruscans, by Otfried Müller, Pt. ii. p. 350; Niebuhr's Roman History, Pt. ii. p. 380.

[46] (p. 165.)—If we assume the fabulous account of Father Angelo Cortenovis, in Germany, that the tomb of the hero of Clusium, Lars Porsena, described by Varro, and furnished with a brazen helmet, and a brazen chain hanging down, was a collector of atmospheric electricity, or an apparatus for conducting the lightning; as, according to Michaelis, the metallic points upon Solomon's temple, are said to have been; it must have occurred at a time when mankind possessed the remnants of an original knowledge of natural philosophy, which was speedily clouded over again. Respecting the early discovered connection between lightning and conducting metals, the most important notice seems to me to have been that of Ctesias (Indicâ, cap. iv. p. 169, ed. Lion, p. 248, ed. Baehr). He said, "He has two iron swords in his possession, presents from the king (Artaxerxes Mnemon), and his mother (Parysatis); these swords, if planted in the earth, turned aside clouds, hail, and lightning. He has himself seen their effect; for the king had made the experiment twice before his eyes." The close attention paid by the Tuscans to the meteorological processes of the atmosphere, and to everything which varied

from the ordinary course of nature, makes it certainly a subject of regret, that none of the lightning-books has come down to us. The epochs of the appearance of great comets, of the fall of meteoric stones, and the crowds of falling stars, were, without doubt, as clearly laid down in them, as in the more ancient Chinese annals used by Edward Biot. Creuzer (Symbols and Mythology of the Ancient Nations, pt. iii. 1842. p. 659), has attempted to shew how the peculiarity of the country in Etruria has produced the characteristic direction of the mind in its inhabitants. The enticing of the lightning, attributed to Prometheus, reminds us of the wonderful pretended attraction of the lightning by the Fulguratores. This operation, however, consisted merely in exorcising it, and may certainly, not have been found more effective than the carved ass's head, by means of which, according to the customs of the Tuscan religion, they were defended during a thunder storm.

47 (p. 165.)—Otfried Müller's Etruscans, Pt. ii. 162—178. According to the complex Etrurian theory of Auguries, the *soft, warming* lightning which Jupiter sent down, by his own authority and power, was distinguished from the more violent electrical mode of castigation which, according to the constitution of the heavens, he only dared send down after a previous consultation with all the twelve gods. (Senec. Nat. Quæst. ii. 41.)

48 (p. 165.)—Joh. Lydus de Ostentis ed. Hase, p. 18, in the preface.

49 (p. 166.)—Strabo, lib. iii. p. 139, Casaub. Compare William von Humboldt, upon the Original Inhabitants of Spain, 1821, p. 123 and 131—136. M. de Saulcy has lately very happily employed himself in deciphering the Iberian alphabet, as Grotefend, the acute discoverer of the Cuneiform inscriptions did with the Phrygian, and Sir Charles Fellows with the Lycian alphabet.

50 (p. 167.)—Herod. iv. 42, (Schweighäuser ad Herod. vol. v. p. 204). Compare Humboldt, Asie Centrale, vol. i. p. 54 and 577.

51 (p. 168.)—Concerning the probable etymology of Caspapyrus of Hecatæus (Fragm. ed. Klausen, No. 179, v. 94, and Caspatyrus of Herodotus (iii. 102, and iv. 44); *vide* my "Asie Centrale," vol. i. p. 101—104.

52 (p. 168.)—Psemetek and Achmes, *vide* above, Kosmos, vol. ii. p. 152—153.

53 (p. 168.)—Droysen's History of the civilization of the Grecian States, 1843, p. 23.

[54] (p. 168.)—Kosmos, vol. ii. p. 8.

[55] (p. 169.)—Völker, mythical Geography of the Greeks and Romans. Pt. i. 1832, p. 1—10; Clausen upon the wanderings of Io and Hercules, in Niebuhr's and Brandi's Rhenish Museum for Philology, History and Grecian Philosophy, year iii. 1829, p. 293—323.

[56] (p. 169.)—In the fable of Abaris (Herod. iv. 36,) the wonderful man does not travel upon an arrow through the air, but he carries the arrow, "which Pythagoras gave him (Jambl. de vita Pythag. xxix. p. 194. Kiessling), so that he might use it in all hindrances which he might meet with in his long and wandering course;" Creuzer's "Symbols," Pt. ii. 1841, p. 660—664. Respecting the Arimaspian singer, Aristes of Proconnesus, who disappeared so frequently, and appeared again, *vide* Herod. iv. 13—15.

[57] (p. 169.)—Strabo, lib. i. p. 38, Casaub.

[58] (p. 170.)—Probably the valley of the Don, or of the Cuban; compare my 'Asie centrale,' vol. ii. p. 164. Pherecydes says expressly (fragment 37, ex Schol. Apollon. ii. 1214) Caucasus had burnt, and therefore Typhon had fled to Italy; a notice, by which Claussen (op. cit. p. 298) explains the ideal relation of the Prometheus the kindler of fire, to be a fiery mountain. But although the geological formation of Mount Caucasus, recently so thoroughly investigated by Abich, and its connection with the volcanic Celestial Mountains (Thian-schan) of central Asia, which I believe I have elsewhere pointed out ('Asie centrale,' vol. ii. p. 55—59), render it by no means improbable that recollections of great volcanic phenomena may have been preserved amongst the most ancient traditions of mankind, yet it must first be assumed that the etymological ideas of the Greeks led to the hypothesis of the burning. Respecting the Sanscrit etymology of Graucasus (Glanz-berg, shining hill?) *vide* Bohlen's and Burnouf's expressions in my 'Asie centrale,' vol. i. p. 109.

[59] (p. 171.)—Otfried Müller's Minyans, p. 247, 254 and 274. Homer did not know Phasis, Colchis, nor the Pillars of Hercules; but Phasis was known in the time of Hesiod. The fabulous traditions respecting the return of the Argonauts through the Phasis in the Eastern Ocean and through the supposed bifurcation of the Ister, or the *Triton Sea*, divided and formed by volcanic concussions, ('Asie centrale,' vol. i. p. 179, vol. iii. p. 135—137; Otfried Müller's Minyans, p. 357) are of especial importance in making us acquainted with the earliest notions

prevalent respecting the forms of the continents. Geographical fancie of Pisander, Timagetus and Apollonius Rhodius have at any rate extended into the latter part of the Middle Ages; and they have been at one time hindrances which led astray or terrified inquirers from the truth, at another inducements to real discoveries. This reflected influence of antiquity upon later times, in which men have been almost more convinced by the opinions of others than by actual observation, has not been sufficiently noticed hitherto in the history of geography. It is the object of these 'notes' to Kosmos, not only to give the bare bibliographical sources from various literary works to illustrate the opinions expressed in the text; but I have wished in them to allow a freer scope and also more copious materials, for consideration of the subject, as I have been able to collect them by my own experience and by long literary studies.

[60] (p. 171.)—Hecatæi fragm. ed Klausen. p. 39, 92, 98 and 119. *Vide* also my inquiries respecting the history of the geography of the Caspian, from the time of Herodotus to the Arabians, El-Istachri, Edrisi and Ibn-el-Vardi, and respecting the Sea of Aral, the bifurcations of the Oxus and the Araxes in my 'Asie centrale,' vol. ii. p. 162—297.

[61] (p. 171.)—Cramer 'de studiis quæ veteres ad aliarum gentium contulerint linguas,' 1844, p. 8 and 17. The ancient Colchians appear to be identical with the race of Lazi (Gentes Colchorum, Plin. vi. 4; the Λαζοί of the Byzantine writers); *vide* Vater, (Professor at Casan), who represents the voyage of the Argonauts from the origin, 1845, Pt. i. p. 24, Pt. ii. p. 45, 57 and 103. In the Caucasus these names are still heard; *Alani*, (Alanethi in the land of the Alani), *Ossi* and *Ass*. According to the works of George Rosen, begun with a philosophical idea of language in the valleys of the Caucasus, the language of the Lazi contains the remnants of the ancient Colchian idiom. The Iberian and Grusian family of languages includes that of the Lazi, Georgians, Suani and Mingrels, all belonging to the Indo-germanic family. The language of the Ossetes is more nearly allied to the Gothic than to the Lithuanian.

[62] (p. 171.)—Respecting the relationship of the Scythians, (Scoloti or Sacæ), Alani, Goths, Massa-getes and Yueti of the Chinese historians, *vide* Klaproth in his commentary to the *Voyage du Comte Potocki*, vol. i. p. 129, and also my 'Asie centrale,' vol. i. p. 400, vol. ii. p. 252. Procopius says with great decision ('de bello Gothico,' iv. ed. Bonn, 1833,

vol. ii. p. 476) that the Goths were formerly named Scythians. The identity of the Getæ and Goths has been pointed out by Jacob Grimm in his newest Treatise upon *Jornandes*, 1846, p. 21. Niebuhr's supposition (*vide* his 'Inquiries respecting the Getæ and Sarmatians,' in his 'lesser Historical and Philological Writings,' 1st. collection, 1828, p. 362, 364 and 395) that the Scythians of Herodotus belong to the family of the Mongolian races, is so much the more improbable because the latter, even in the beginning of the 13th century, lived under the yoke of the Chinese, and the Hakas and Kirghishes (Χερχίς, of Menander) far in the east of Asia, around the Baikal Sea. Herodotus moreover distinguishes the bald-headed Argippæans (iv. 23) from the Scythians; and says that if the former are 'flat-nosed' yet they have also 'a long chin'; according to my own experience, this is by no means a characteristic sign of the Kalmuck or other Mongolian races; but rather a peculiarity of the blond (Germanic) races of the Usün and Tingling, to whom the Chinese historians attribute "long horses' faces."

63 (p. 171.)—Concerning the land of the Arimaspians and their trade in gold in the north-west of Asia in the time of Herodotus, *vide* my 'Asie centrale,' vol. i. p. 389—407.

64 (p. 172.)—"Les Hyperboréens sont un mythe météorologique. Le vent des montagnes (B'Oreas) sort des Monts Rhipéens. Au-delà de ces monts, doit régner un air calme, un climat heureux, comme sur les sommets alpins, dans la partie qui dépasse les nuages. Ce sont là les premiers aperçus d'une physique qui explique la distribution de la chaleur et la différence des climats par des causes locales, par la direction des vents qui dominent, par la proximité du soleil, par l'action d'un principe humide ou salin. La conséquence de ces idées systématiques était une certaine indépendance qu'on supposait entre les climats et la latitude des lieux: aussi le mythe des Hyperboréens, lié par son origine au culte dorien et primitivement boréal d'Apollon, a pu se déplacer du nord vers l'ouest, en suivant Hercule dans ses courses aux sources de l'Ister, à l'île d'Erythia et aux Jardins des Hespérides. Les Rhipes ou Monts Rhipéens sont aussi un nom significatif météorologique. Ce sont les montagnes de l'*impulsion* ou du souffle glacé (ῥιπή), celles d'où se déchaînent les tempêtes boréales."—Asie centrale, t. i. p. 392 and 403.

65 (p. 172.)—In the Hindustanee language (as Wilford has well remarked,) there are two words which might easily be confounded: the

one, *tschiânta*, means a large black species of ant (whence the diminutive, *tschiûnti*, *tschînti*, the little, ordinary species); the other, *tschînta*, means a spotted kind of panther, the little hunting leopard (*Felis jubata*, Schreb.) The last word is the Sanscrit word, *tschitra*, variegated, spotted, as the Bengal name for the animal (*tschitâbâgh* and *tschitibâgh*, from *bâgh*, Sanscrit, *wyâghra*, a tiger) proves (Buschmann).—In the Mahabharata (ii. 1860) a passage has recently been discovered in which the gold of the ants is alluded to. "Wilso invenit (Journal of the Asiatic Society, vol. vii. 1843, p. 143) mentionem fieri etiam in Indicis litteris bestiarum aurum effodientium, quas, quum terram effodiant, eodem nomine (pipilica) atque formicas Indi nuncupant." Compare Schwanbeck, in Megasth. Indicis 1846, p. 73. I was much struck with seeing that in the basaltic regions of the highlands in Mexico, the ants collect together the shining particles of Hyalite, which I was enabled to take out of the ants' nests.

[66] (p. 176.)—In Strabo, lib. iii. p. 172, Böckh, Pindar. Fragm. v. 155.)—The voyage of Colæus of Samos, according to Otfried Müller, happened in the 31st Olympiad, (*Prolegomena to a Scientific Mythology*), and according to Letronne's inquiry (Essai sur les idées cosmographiques qui se rattachent au nom d'Atlas, p. 9) in the 1st year of the 35th Olympiad, that is, in the year 640. The epoch depends upon the founding of Cyrene, which Otfried Müller (Minyans, p. 344; Prologmena, p. 63) places between the 35th and 37th Olympiad, for at the time of Colæus they were not acquainted with the way from Thera to Libya (Herod. iv. 152). Zumpt considers the founding of Carthage to be 878 B.C.; that of Gades 1100 B.C.

[67] (p. 176.)—According to the custom of the ancients, (Strabo, lib. ii. p. 126), I include the whole of the Euxine with the Lake Mæotis, as geological and physical research require, as being a part of the common basin of the Mediterranean.

[68] (p. 176.)—Herod. iv. 152.

[69] (p. 176.)—Herod. i. 163, where the discovery of Tartessus is ascribed to the Phocæans; but the trading enterprises of the Phocæans, according to Ukert (Geograph. of the Greeks and Romans, Pt. i. 1. p. 40), were 70 years after Colæus of Samos.

[70] (p. 177.)—According to a fragment of Phavorinus, the words ὠκεανός and ὠγήν are not Grecian, but borrowed from the Barbarians (Spohn de

Nicephor. Blemm. duobus opusculis, 1818, p. 23). My brother believes that they are connected with the Sanscrit roots *ogha* and *ogh*. (*Vide* Examen critique de l'histoire de la Géographie, vol. i. p. 33 and 182).

[71] (p. 177.)—Aristot de Cœlo, ii. 14, (p. 298, b. Bekk.), Meteor. ii. 5, (p. 362. Bekk.); compare my "Examen critique," vol. i. p. 125—130. Seneca is bold enough to say, (Nat. Quæst. in præfat. 11), "contemnet curiosus spectator domicilii (terræ) angustias. Quantum enim est quod ab ultimis littoribus Hispaniæ usque ad Indos jacet? *Paucissimorum dierum spatium*, si navem suus ventus implevit. (Examen crit. vol. i. p. 158).

[72] (p. 177.)—Strabo, lib. i. p. 65 and 118 Casaub. (Examen crit. vol. i. p. 152.)

[73] (p. 178.)—In the *Diaphragm* (the line of division) of Dicæarchus, the elevation runs through Mount Taurus, the chains of Demavend and Hindu-Kho, the northern Tibetan Kuen-lün and the snow-capped mountains of the Chinese provinces, Sse-tschuan and Kuang-si. *Vide* my orographical investigations respecting this line of elevation in my 'Asie centrale,' vol. i. p. 104—114, 118—164; vol. ii. p. 413 and 438.

[74] (p. 178.)—Strabo, lib. iii. p. 173, (Examen crit. vol. iii. p. 98).

[75] (p. 180.)—Droysen, History of Alexander the Great, p. 544; and the same author, in his History of the Civilization of the Grecian States p. 23—34, 588—592, 748—755.

[76] (p. 180.)—Aristot. Polit. vii. 7, p. 1327 Bekker, (compare also iii. 16, and the remarkable passage of Eratosthenes in Strabo, lib. i. p. 66, and 97 Casaub.)

[77] (p. 181.)—Stahr, Aristotelia, Pt. ii. p. 114.

[78] (p. 181.)—Ste. Croix, "Examen critique des historiens d'Alexandre," p. 731 (Schlegel, Indian Library, vol. i. p. 150.)

[79] (p. 183.)—Compare Schwanbeck, de fide Megasthenis et pretio, in his edition of this author, p. 59—77. Megasthenes often visited Palibothra, the Court of the King of Magadha. He was deeply read in the Chronology of the Indians, and reports "how in past ages everything had attained freedom three times, and three ages of the world had passed away, and that in his time the fourth had commenced," (Lassen's Indian Antiquity, vol. i. p. 510). The doctrine of Hesiod of four ages of the world, united to four complete destructions of the world, which together fill a space of 18028 years, is found among the Mexicans also, (Humboldt, Vues des Cordillères et Monumens des peuples indigènes de l'Amérique,

vol. ii. p. 119—129).—In later times the study of the Rigveda and the Mahabharata has afforded a remarkable proof of the accuracy of Megasthenes. Compare what Megasthenes reports "respecting the land of the long-lived Blessed in the farthest north of India, and the land *Uttara-Kuru*, (probably north of Kashmir, towards the Belurtagh), which according to his Grecian notions he annexes to the 1000 years of the life of the Hyperboreans" (Lassen in the Journal of Eastern learning, vol. ii. p. 62). With this account we may connect a tradition preserved by Ctesias, which has been too long neglected, concerning a holy place in the northern deserts (Ind. cap. 8, ed. Baehr, p. 249 and 285). Ctesias described as a real animal the Martichoras which Aristotle mentions (Hist. de Animal, ii. 3, §. 10, vol. i. p. 51, Schneider), the Griffins, which were half eagles, half lions, and the Cartazonon, mentioned by Ælian, a wild ass with one horn; he does not bring them forward as his own fabrication, but because, as Heeren and Cuvier have remarked, he had seen the forms of animals represented as symbols upon the Persian monuments and considered them to be resemblances of living beasts from the distant regions of India. The accurate identification of the Martichoras with the Persepolitan symbols, is, according to the remark of the acute inquirer, Guigniaut, a matter of considerable difficulty, (Creuzer, Religions de l'Antiquité; notes et éclaircissements, p. 720).

[30] (p. 184.)—I have explained the orographical relations of these regions, in my "Asie Centrale," vol. ii. p. 429—434.

[31] (p. 184.)—Lassen, in the Journal for Eastern Learning, vol. i. p. 230.

[32] (p. 185.)—The land between Bamian and Ghori. *Vide* Carl Zimmerman's splendid orographical View of Afghanistan, 1842. (Compare Strabo, lib. xv. p. 725. Diod. Sicul. xvii. 82; Menn, Meletem. hist. 1839, p. 25 and 31. Ritter upon Alexander's March to Indian Caucasus, in the Treatises of the Berlin Academy, of the year 1829, p. 150; Droysen, Civilization of the Grecian States, p. 614.) I write Paropanisus, as all good manuscripts of Ptolemæus have it, and not Paropamisus.—The reasons have been narrated in my "Asie Centrale," vol. i. p. 114—118 (compare also Lassen, upon the History of the Grecian and Indian Scythian Kings, p. 128.)

[33] (p. 185.)—Strabo, lib. xv. p. 717, Casaub.

[34] (p. 185.)—*Tala*, being the name of the Palm, *Borassus flabelliformis*,

(called very characteristically by Amarasinha, the King of Grasses,) Arrian, Ind. vii. 3.

[85] (p. 185.)—The word *tabaschir* is derived from the Sanscrit word ***tvak-kschîrâ*** (cow's milk); *vide* above p. 402, note 3. I have already, in 1817, in the historical appendix to my work, "De Distributione geographica Plantarum secundum cœli temperiem et altitudinem montium," remarked in p. 215, that besides the Tabaschir of the Bamboo, the companions of Alexander (Strabo lib. xv. p. 693, *Peripl. maris. Erythr.* p. 9), also became acquainted with the true cane-sugar of the Indians. Moses of Chorene, who lived in the middle of the fifth century, was the first to describe circumstantially (Geogr. ed. Whiston, 1736, p. 364), the preparation of sugar from the juice of the "Saccharum Officinarum," in the province of Chorasan.

[86] (p. 185.)—Strabo, lib. xv. p. 694.

[87] (p. 185.)—Ritter's Geography of Asia, vol. iv. 1. p. 437, vol. vi. 1. p. 698; Lassen's Indian Antiquity, vol. i. p. 317—323. The passage in Aristotle's Hist. de Animal, v. 17, (vol. i. p. 209, ed. Schneider) of the web of a great horned caterpillar refers to the island of Cos.

[88] (p. 185.)—Like λάκκος χρωμάτινος im Peripl. maris Erythr. p. 5. (Lassen. p. 316).

[89] (p. 185.)—Plin. Hist. Nat. xvi. 32. (Upon the transplantation of rare Asiatic plants into Egypt by the Lagides, *vide* Plin. xii. 14 and 17.)

[90] (p. 186.)—Humboldt, de Distributione Geograph. Plantarum, p. 178.

[91] (p. 187.)—I have frequently corresponded with Lassen, since the year 1827, respecting the remarkable passage in Pliny. xii. 6. "Major alia (arbor) pomo et suavitate præcellentior quo sapientes Indorum vivunt. Folium alas avium imitatur, longitudine trium cubitorum, latitudine duûm. Fructum cortice mittit, admirabilem succi dulcedine ut uno quaternos satiet. Arbori nomen *palæ*, pomo *arienæ*." The following is the result of the investigations of my learned friend; "Amarasinha places the Musa (Banana, Pisanga) at the head of all nutritive plants. Among the numerous Sanscrit names which he adduces, we find, *varanabuscha*. *bhanuphala* (sun-fruit) and *moko*, whence the Arabian word *mauza*. *Phala* (pala), means fruit in general, and is, therefore, only taken for the name of a plant by mistake. *Varana* does not appear in Sanscrit as the name of the Pisanga without *buscha*, but the abbreviation may have belonged to the popular language; *varana* was the Greek word οὐάρενα, which is certainly not very far removed from *ariena*." Compare Lassen, Indian

Antiquity, vol. i. p. 262; my political essay upon New Spain, vol. ii. 1827, p. 382, Relation Historique, vol. i. p. 491. Prosper Alpinus and Abd-Allatif both suspected the chemical resemblance between nutritive amylum and sugar, whilst they endeavoured to explain the origin of the banana, from the insertion of the sugar-cane, or sweet-date palm into the roots of the Colocasia. (Abd-Allatif, Relation de l'Egypte, trad. par Silvestre de Sacy, p. 28 and 105.)

92 (p. 186.)—Compare, respecting this epoch, William von Humboldt, in his work upon the Cawi language, and the difference of the structure of languages, vol. i. p. ccl. and ccliv.; Droysen's History of Alexander the Great, p. 547, and Grecian States, p. 24.

93 (p. 187.)—Dante, Inferno. iv. 130.

> "Afar the master of the studious sect,
> Who taught fair truth from falsehood to select,
> His pupils led . . . . ."

94 (p. 187.)—Compare Cuvier's suppositions in the "Universal Biography," vol. ii. 1811, p. 458 (again appearing in the edition of 1843, vol. ii. p. 219), with Stahr's Aristotelia, pt. i. p. 15 and 108.

95 (p. 187.)—Cuvier, in working out an account of the life of Alexander the Great, believed that he did accompany him, "whence the Stagirite is supposed to have collected all his materials for his *Historia Animalium*, and brought them to Athens in the second year of the 112th Olympiad." Afterwards (1830), this great natural investigator gave up the opinion, because, upon close inquiry, he remarked, "that the description of the Egyptian animals was not sketched from life, but after notices from Herodotus." Compare Cuvier, Histoire des Sciences Naturelles, publiée par Magdeleine de Saint-Agy, vol. i. 1841, p. 136).

96 (p. 187.)—Among the internal testimonies we may mention; the notions which they entertained respecting the perfectly separated and isolated position of the Caspian Sea—the account of the great comets which appeared in the time of the ruler Nichomachus, in the fourth year of the 109th Olympiad, according to Corsini, not to be confounded with that which M. Boguslawski has recently called Aristotle's Comet (in the time of the ruler Asteus, Ol. 114, 4; Aristot. Meteor. lib. i. cap. vi. 10, vol. i. p. 395. Ideler; identical with the comets of 1695 and 1843?); the mention of the destruction of the temple of Ephesus, and of the lunar rainbow seen twice in the course of fifty years. (Compare Schneider ad

Aristot. Hist. de Animalibus, vol. i. p. xl. xlii. ciii. and cxx.; Ideler and Aristot Meteor. vol. i. p x.; Humboldt, Asie Centrale, vol. ii. p. 168). That the *Histor. Animal* was written after the *Meteorologica*, may also be known from the fact, that in the latter, he alludes to the former as to something soon about to follow. (Meteor i. 1, 3, and iv. 12, 13.)

[97] (p. 188.)—The five animals named in the text, and of these especially, the Hippelaphus (stag with a beard and long mane), the Hippardion, the Bactrian camel, and the buffalo, are brought forward by Cuvier, as a proof of the later date of the *Historia Animalis* of Aristotle (Hist. des Sciences Nat. vol. i. p. 154). Cuvier distinguishes, in the fourth volume of his splendid "Recherches sur les Ossemens fossiles," 1823, p. 40—43, and p. 502, between the two bearded stags of Asia, which he calls the Cervus Hippelaphus and Cervus Aristotelis. At first, he considered, that the former, a living specimen of which he saw in London, and of which Diard had sent him the skins and viscera from Sumatra, was the Hippelaphus of Aristotle, from Arachosia (Hist. de Animal ii. 2, sect. 3 and 4, vol. i. p. 43—44, Schneider); afterwards the head of a stag sent to him by Duvaucel, from Bengal, seemed, according to the representation of the entire great animal, to correspond more completely with the description of the Hippelaphus by the Stagirite. The latter, which is indigenous in the Bengal mountains of Sylhet, in Nepaul, and east of the Indus, now retains the name of *Cervus Aristotelis*. If, in the same chapter in which Aristotle speaks generally of animals with manes, besides the Horse-stag (*Equicervus*), the Indian guepard, a hunting tiger (*Felis jubata*) is meant, the best reading is, as Schneider says (vol. iii. p. 66), πάρδιον and not τὸ ἱππάρδιον. The latter reading would better indicate the Giraffe, as Pallas thinks (Spicileg. zool. fasc. i. p. 4). If Aristotle himself had seen the Guepard, and had not only heard a description of it, how is it possible that he could have neglected to mention the claws in a feline animal, not retractile! It is also remarkable, that Aristotle, who is always so accurate in his observations, if he really (as August William von Schelegel supposes), "had a menagerie near his dwelling, at Athens, and had himself dissected an elephant taken at Arbela," should not have described the little aperture near the temples, in which, especially at the time of heat, a strong smelling fluid is secreted, and to which the Indian poets so often allude (Schlegel's Indian Library, vol. i. p. 163—166). I here particularly record the apparently insignificant circumstance, because the glandular opening to which I have just alluded,

was known to us by the reports of Megasthenes (Strabo lib. xv. p. 704 and 705 Casaub.), and yet no one appears to have known its anatomical structure. I find in the various zoological works of Aristotle, which are extant, nothing to enable us to conclude necessarily, that he had himself observed or dissected an elephant. Nevertheless, we cannot deny the possibility that the author of the *Historia Animalium* might (as Stahr supposes), have completed the work, and added to it, even until the end of his life, (third year of the 114th Olympiad, and, therefore, three years after the death of the great conqueror), although it was probably finished before the campaign of Alexander into Asia Minor (Aristotelia, pt. ii, p. 98); we have, however, no direct testimony for this. None of the correspondence of Aristotle which we possess is genuine (Stahr, pt. i. p. 194—208; pt. ii. p. 169—234), and Schneider says, with great energy (Hist. de Animal, vol. i. p. 40); "hoc enim tanquam certissimum sumere mihi licebit, scriptas comitum Alexandri notitias post mortem demum regis fuisse vulgatas."

98 (p. 188.)—I have elsewhere shown, that although the decomposition of sulphuretted mercury, by means of distillation, is described in Dioscorides (Mat. Medica. v. 110, p. 667, Saracen), yet the first description of the distillation of a fluid (in the art of changing sea-water into fresh-water), is found in the Commentary of Alexander of Aphrodisia, in the book of the *Meteorologica* of Aristotle; *vide* my "Examen Critique de l'Hist. de la Géograph." vol. ii. p. 308—316, and Johannis (Philoponi) Grammatici in libr. de Generat. et Alexandri Aphrod. in Meteorol. Comm. Venet. 1527, p. 97, b. Alexander of Aphrodisia, in Carien, the learned commentator upon the *Meteorologica* of Aristotle, lived in the time of Septimus Severus and Caracalla; and although chemical apparatus is, in his writings, called χυικὰ ὄργανα, yet, a passage in Plutarch (de Iside et Osir, c. 33), proves that the word "Chemistry" was applied to the Egyptian art by the Greeks, and was not derived from χέω (Höfer, Histoire de la Chimie, vol. i. p. 91, 195 and 219, vol. ii. p. 109.)

99 (p. 188.)—Compare Sainte Croix; Examen des Historiens d'Alexandre, 1810, p. 207, and Cuvier, Hist. des Sciences Nat. vol. i. p. 137, with Schneider ad Aristot. de Hist. Animal. vol. i. p. 42—46, and Stahr's Aristotelia, pt. i. p. 116—118. Although it is improbable that specimens were sent from Egypt and Central Asia, yet, on the other hand, the most recent works of our great anatomist, Johann Müller, shew with what

wonderful fineness Aristotle dissected the fishes from the Grecian seas. *Vide* concerning the adhesion of the ovum with the uterus, in one of the two living species of the genus *Mustelus*, from the Mediterranean, which in the fœtal condition, possesses a yolk-bag, and which is in connection with the uterine placenta of the parent animal, the learned treatise of Johann Müller, and his investigations respecting the γαλεὸς λεῖος of Aristotle, in the Transactions of the Berlin Academy of the year 1840, p. 192—197. (Compare Aristot. Hist. Animal. vi. 10, and de Gener. Animal iii. 3). In the same way, the distinctions and the complete dissection of the Cuttle-fish species, the description of the teeth in snails, and the organs of the other Gasteropods, prove that the Stagirite philosopher was himself employed in fine dissections (Compare Hist. Animal iv. 1 and 4, with Lebert in Müller's "Physiological Archives." 1846, p. 463 and 467). Respecting the form of the teeth of snails, I have myself, as early as 1797, drawn the attention of more recent historians; *vide* my Experiments upon the irritability of muscular and nervous fibrils, vol. i. p. 261.

[100] (p. 189.)—Valer. Maxim. vii. 2; "ut cum Rege aut rarissime, aut quam jucundissime loqueretur."

[101] (p. 190.)—Aristot. Polit. 1, 8, and Ethic. ad Eudemum, vii. 14.

[102] (p. 190.)—Strabo, lib. xv. p. 690 and 695 (Herod. iii. 101.)

[103] (p. 190.)—So Theodectes of Phaselis; *Vide* above, Kosmos, vol. i. p. 385 and 480. Everything to the north was rather ascribed to the west, and what was south, to the east; compare Völcker upon Homeric Geography, p. 43 and 87. The uncertainty of the word "India," even at that early date, united with ideas of position, of the colour of the inhabitants, and precious productions, aided in extending those meteorological hypotheses; for "India" meant, at the same time, western Arabia, the land between Ceylon and the mouth of the Indus, the troglodytic Ethiopia and the African Myrrh and Cinnamon country, south of the promontory of Aroma (Humboldt, Examen Critiq. vol. i. p. 35.)

[104] (p. 191.)—Lassen's Indian Antiquity, vol. i. p. 369, 372—375, 379 and 389; Ritter's Asia, vol iv. 1. p. 446.

[105] (p. 191.)—The geographical distribution of the races of mankind can, as little as that of plants and animals, be determined in entire continents, according to the degree of latitude. The Axiom which Ptolemæus (Geogr. lib. i. cap. 9,) laid down, that north of the parallel of Agisymba, there were no elephants, no rhinoceroses, and no negroes, is

altogether without foundation (Examen. Crit. vol. i. p. 39). The idea of the general influence of the soil and the climate upon the intellectual and moral development of mankind, was still peculiar to the Alexandrine school of Ammonius Saccas, especially to Longinus. *Vide* Proclus, Comment. in Tim. p. 50.

[106] (p. 191.) *Vide* George Curtius, "The comparison of languages in their relation to classical philology, 1845, p. 5—7, and his "Formation of *Tempora and Modi*," 1846, p. 3—9. Compare also Potts' article upon the Indo-germanic languages in the General Cyclopædia, of Ersch and Gruber, sect. ii. pt. xviii. p. 1—112). Inquiries respecting languages in general, as far as they are connected with the original relations of thought, are found in the works of Aristotle, where he develops the union of the categories with grammatical ideas. *Vide* the luminous representation of this comparison, in Adolf Trendelenburg's historical Treatise upon Philosophy, 1846, pt. i. p. 23—32.

[107] (p. 192.) The schools of the Orchenes and Borsipenes. Strabo, lib. xvi. p. 739. In this passage, in connection with the Chaldæan astronomers, four Chaldæan mathematicians are brought forward by name ; this circumstance is so much more important in an historical point of view, because Ptolemæus, considering that the observations in Babylon had been always brought forward as the collective opinion of many (Ideler, Guide to Chronology, vol. i. 1825, p. 198), includes astronomers constantly under the general title of Χαλδαῖοι.

[108] (p. 192.)—Ideler, Op. Cit. vol. i. p. 202, 206, and 218: If we found our doubts as to the results of astronomical observations sent from Babylon to Greece by Callisthenes, upon the fact that (Delambre, Histoire de l'Astronomie Ancienne, vol. i. p. 308), "no trace of these observations of the Chaldæan caste of priests is to be found among the writings of Aristotle;" we forget that (De Cœlo, lib. ii. c. 12), in the very place where he speaks of an occultation of Mars by the moon, which he had himself observed, he adds expressly; "The very same observations respecting the other planets have been made for many years by the Egyptians and Babylonians, from whom many additions to our knowledge have come." Respecting the probable use of astronomical tables by the Chaldæans, *vide* Chasles, in the Comptes rendus de l'Acad. des Sciences, vol. xxiii. 1846, p. 852—854.

[109] (p. 193.)—Seneca, Nat. Quæst. vii. 17.

[110] (p. 193.)—Compare Strabo, lib. xvi. p. 739, with lib. iii. p. 174.

[111] (p. 193.)—These investigations were made in the year 1824. (*vide* Guigniaut, Religions de l'Antiquité, ouvr. trad. de l'Allem. de F. Creuzer, vol. i. pt. ii. p. 928.) Later additions are some which were made by Letronne, in the "Journal des Savants," 1839, p. 338 and 402, and also those in the "Analyse Critique des Représentations Zodiacales en Egypte, 1846, p. 15 and 34. (Compare with this, Ideler, upon the Origin of the Circle of the Zodiac, in the Transactions of the Academy of Sciences at Berlin, in the year 1838, p. 21.)

[112] (p. 193.)—The splendid forests of *Cedrus deodvara* (Kosmos vol. i. p. 45,) generally between eight and eleven thousand feet above the sea, upon the Upper Hydaspes (Behut) which runs through the Alpine valley of Kaschmir, provided the materials for Nearchus' fleet (Burne's Travels, vol. i. p. 59). According to the observations of Dr. Hoffmeister, the companion of Prince Waldemar, of Prussia, who alas! was, for the advance of science, too early taken away by a death upon the battle-field, the trunks of these cedar trees often attained a circumference of forty feet.

[113] (p. 194.)—Lassen, in the "Pentapotamia Indica, p. 25, 29, 57—62, and 77—and also in his "Indian Antiquity," vol. i. p. 91. Between the *Sarasvati*, to the north-west of Delhi, and the rocky *Drischadvati*, according to the law book of *Manu's Brahmavarta*, exists, a divinely appointed district of the priests of Brâhma; on the other hand, in the more extended sense of the word *Aryavarta* (the land of the Worthy, Arians), in the ancient Indian geography, it means the whole district east of the Indus, between the Himalaya and the Vindhya chain of mountains, whence, to the southward, the ancient and original Non-Arian population began. Madhya-Desa "the land of the Middle," which I have above-mentioned (Kosmos, vol. i. p. 15), was a part of Aryavarta. (Compare my "Asie Centrale," vol. i. p. 204, and Lassen's Indian Antiquity, vol. i. p. 5, 10, and 93.) The ancient *Indian Free States*, the districts of the *kingless people* (condemned by the orthodox eastern poets), lies between the Hydravates and Hyphasis, that is, between the present Ravi and the Beas.

[114] (p. 194.)—Megasthenes, Indica ed. Schwanbeck, 1846, p. 17.

[115] (p. 197.)—*Vide* above, Kosmos, vol. ii. p. 150.

[116] (p. 197.)—Compare my geographical inquiries in the "Asie Centrale," vol. i. p. 145 and 151—157; vol. ii. p. 179.

[117] (p. 198.)—Pliny, vi. 26 (?).

[118] (p. 198.)—Droysen, History of the Grecian States, p. 749.

[119] (p. 199.)—Compare Lassen's Indian Antiquity, vol. i. p. 107, 153 and 158.

[120] (p. 199.)—"Corrupted from the word *Tâmbapannî*. This word is spoken in Sanscrit *Tâmraparnî*; the Greek form *Taprobane* reproduces half the Sanscrit word (*Tâmbra, Tapro*), and half the Paliform." (Lassen. op. cit. p. 201; compare Lassen's Dissert. de Taprobane insula, p. 19). Also the Lakedives (*lakke*, instead of *lakscha*, and *dive* instead of *dwîpa*, a hundred thousand islands), were known to the Alexandrine navigators, as were also the Maledives (*Malayadiba, i. e.* Islands of Malabar.)

[121] (p. 200.)—Hippalus is said to have lived in the time of Claudius; but the idea is improbable, even allowing that in the time of the first Lagides, the greater part of the productions of India were bought in the Arabian markets. At any rate, the south-west monsoon was itself called Hippalus, as was also a part of the Erythræan Sea, or Indian Ocean, called the Sea of Hippalus; Letronne, in the Journal des Savans, 1818, p. 405. Reinaud, Relation des Voyages dans l'Inde, vol. i. p. 30.

[122] (p. 201.) *Vide* the investigations of Letronne upon the formation of the canal between the Nile and the Red Sea, from the time of Neku to that of Caliph Omar, in a space of not more than 1300 years, in the Revue de deux Mondes, vol. xxvii. 1841, p. 215—235. Compare also Letronne de la Civilization Egyptienne depuis Psammitichus jusqu' à la conquête d' Alexandre, 1845, p. 16—19.

[123] (p. 201.)—Meteorological speculations respecting the remote causes of the rising of the Nile gave origin to some of these journeys, whilst Philadelphus, as Strabo expresses it, (lib. xvii. p. 789 and 790), "on account of his avidity, was always seeking new pleasures and diversion."

[124] (p. 202.)—Two hunting inscriptions, "of which one particularly records an elephant hunt of Ptolemæus Philadelphus," have been discovered by Lepsius, in his journey in Egypt, upon the Colossus of *Abu-simbel* (Ibsambul), and have been copied. (Compare, respecting this circumstance, Strabo, lib. xvi. p. 769 and 770; Ælian, de Nat. Animal, iii. 34, and xvii. 3; Athenæus v. p. 196.) Although Indian ivory was an article of export from Barygaza to the shores of the Erythræan Sea, yet, according to the account of Cosmas, ivory was also exported

from Ethiopia to the western shores of the Indian peninsula. The elephants, since these ancient days, have, even in eastern Africa, retired more to the south. According to the testimony of Polybius (v. 84), when the African and Indian elephants stood opposite one another, in the field of battle, the appearance, smell and cries of the greater and stronger Indian elephants put the others to flight. The latter have never been so much used for the purposes of warfare as in the Asiatic campaigns, where Kandragupta had 9000, the powerful king of the Prasians 6000, and Akbar himself the same number, collected together. (Lassen's Indian Antiquity, vol. i. p. 305—307.)

125 (p. 202.)—Athen. xiv. p. 654; compare Parthey, "The Alexandrian Museum," a prize essay, p. 55 and 171.

126 (p. 203.)—The library of Bruchium was the oldest, and was destroyed at the burning of the fleet in the time of Julius Cæsar. The library of Rhacotis made a part of the Serapeum, where it was united with the museum. The collection of books at Pergamus, was, by the generosity of Anthony, incorporated with the library of Rhaçotis.

127 (p. 203.)—Bacherot. Histoire Critique dè l'Ecole d'Alexandrie, 1846, vol. i. p. 5, and 103. There were, even in antiquity, many proofs that the institution of Alexandria, like all academical corporations, besides having a beneficial effect resulting from the co-operation of the powers of its members, and the means of obtaining instruments and other methods in aid of research, also, to a certain extent, limited and tyrannized over their attempts. Before this splendid city became the melancholy seat of the Christian controversies on the subject of theology, Adrian appointed his tutor, Vestinus, high-priest of Alexandria, (a kind of minister of public worship), and, at the same time, the head of the museum (President of the Academy). Letronne, Recherches pour servir à l'histoire de l'Egypte pendant le domination des Grecs et des Romains 1823, p. 251.

128 (p. 204.)—Fries, History of Philosophy, vol. ii. p. 5, and his text-book for the Study of Nature, pt. i. p. 42. Compare also the observations upon the influence exercised by Plato upon the foundation of the experimental sciences, by the application of mathematics, in Brandis, History of the Grecian and Roman Philosophy, pt. ii. sect. i. p. 276.

129 (p. 205.)—Upon the physical and geognostic opinions of Eratosthenes, *vide* Strabo, lib. i. p. 49—56; lib. ii. p. 108.

[130] (p. 205.)—Strabo, lib. xi. p. 519. Agathem. in Hudson, Geogr. Græci min. vol. ii. p. 4. Upon the correctness of the grand orographical view of Eratosthenes, *vide* my "Asie Centrale," vol. i. p. 104—150, 198, 208—227, 413—415, vol. ii. p. 367 and 414—435, and Examen Critique de l'Histoire de la Géograph. vol. i. p. 152—154. I have intentionally called the measurement of degrees by Eratosthenes, the *first Grecian measurement*, because it is not improbable that an ancient Chaldæan decision respecting the size of a degree, was made by the steps of the camels. *Vide* Chasles, Recherches sur l'Astronomie Indienne et Chaldéene, in the Comptes rendus de l'Acad. des Sciences, vol. xxiii. 1846. p. 851.

[131] (p. 206.)—The latter of these titles appears to me to be the correct one, for Strabo (lib. xvi. p. 739), mentions a "Seleucus of Seleucia, among many very meritorious men, as a Chaldæan astronomer." Here Seleucia, on the Tigris, is probably meant, a flourishing trading city. It is certainly wonderful, that Strabo also names a Seleucus, as an accurate observer of the ebbing and flowing of the tide, a Babylonian (lib. i. p. 6), and again afterwards (lib. iii. p. 174), perhaps from carelessness, calls him an Erythræan. (Compare Stobæus, Ecl. Phys. p. 440).

[132] (p. 206.)—Ideler, Handbook of Chronology, vol. i. p. 212 and 329.

[133] (p. 206.)—Delambre, Histoire de l'Astronomie ancienne, vol. i. p. 290.

[134] (p. 206.)—Böckh, in his *Philolaus* (p. 118), has inquired whether the Pythagoreans were acquainted with the Precession from Egyptian sources, in a work entitled "Movement of the firmament of fixed stars." Letronne (Observations sur les représentations zodiacales, qui nous restent de l'Antiquité, 1824, p. 62), and Ideler (Handbook of Chronology vol. i. p. 192,) attribute this discovery exclusively to Hipparchus.

[135] (p. 207.)—Ideler upon Eudoxus, p. 23.

[136] (p. 208.)—The planet discovered by Le Verrier.

[137] (p. 209.)—Compare above, Kosmos, vol. ii. p. 136, 141, 144 and 165.

[138] (p. 210.)—William von Humboldt, upon the Cawi language, vol. i. p. 37.

[139] (p. 211.)—The superficial contents of the Roman empire, in the time of Augustus, was, according to the boundaries assumed by Heeren, in his "History of Ancient States," (p. 403—470), and, according to Professor

Berghaus, the author of the splendid *Physical Atlas*, rather more than 100,000 square geographical miles; almost a quarter more than the number (1,600,000 square miles) is given, with considerable uncertainty, by Gibbon, in his History of the Decline of the Roman Empire, vol. i. chap. i. p. 39.

140 (p. 212.)—Veget. de re mil. iii. 6.

141 (p. 212.)—Act ii. v. 371, in the famous Prophecy, which since the time of Columbus' son, has been referred to the discovery of America.

142 (p. 213.)—Cuvier, Hist. des Sciences naturelles, vol. i. p. 312—328.

143 (p. 213.)—Liber Ptholemei de opticis sive aspectibus, the rare manuscript in the Royal Library of Paris, No. 7310, which I examined when I was looking for the remarkable passage in Sextus Empiricus (adversus Astrologos, lib. v. p. 351 Fabr.) upon the refraction of light. The extracts which I made from the Paris manuscript in 1811, and therefore before the time of Delambre and Venturi, are in the introduction to my "Recueil d'Observations astronomiques," vol. i. p. lxv—lxx. The Greek original has not been preserved, but a Latin translation of two Arabic manuscripts of the Optics of Ptolemæus exists. The Latin translator calls himself Amiracus Eugenius, a Sicilian. Compare Venturi, Comment. sopra la storia e le teorie dell' Ottica, (Bologna, 1814), p. 227; Delambre, Hist. de l'Astronomie ancienne, (1817), vol. i. p. li. and vol. ii. 410—432.

144 (p. 213.)—Letronne proves from the Christian fanatical murder of the daughter of Theon of Alexandria, that the age of Diophantus, a point so much contested, cannot fall later than the year 389. (Sur l'origine grecque des Zodiaques prétendus égyptiens, 1837, p. 26).

145 (p. 216.)—This improvement in morals (an inclination to more humane feelings) has been well represented by Pliny in broad terms, in his praise of Italy; "omnium terrarum alumna eadem et parens, numine Deum electa, quæ sparsa congregaret imperia ritusque molliret, et tot populorum discordes ferasque linguas sermonis commercio contraheret, colloquia, et humanitatem homini daret, breviterque una cunctarum gentium in toto orbe patria fieret." (Plin. Hist. nat. iii. 5).

146 (p. 217.)—Klaproth, Tableaux historiques de l'Asie, 1826, p. 65—67.

147 (p. 217.)—The Usiun, Tingling, Hutis and the great race of Yueti belong to these fair, blue-eyed, Indo-germanic, Gothic or Arian races of eastern Asia. The Yueti were considered to be a nomad race from Thibet, by the Chinese authors: and it was thought that about 300

years before our era, they migrated to the country between the upper course of the Huangho and the Snow Mountains of Nanschan. I here allude to this descent, because the Seres (Plin. vi. 22) were equally described 'rutilis comis et cæruleis oculis.' (Compare Ukert, Geogr. of the Greeks and Romans, Pt. iii. sect. 2, 1845, p. 275). For our acquaintance with these fair races, which originated in the east of Asia, and gave the first impulse to the so-called *great national emigrations*, we have to thank the investigations of Remusat and Klaproth; they are some of the brightest historical discoveries of our age.

148 (p. 218.)—Letronne in the 'Observations critiques et archéologiques sur les représentations zodiacales de l'Antiquité,' 1824, p. 99, as also in his more recent work 'sur l'origine grecque des Zodiaques prétendus égyptiens,' 1837, p. 27.

149 (p. 218.)—The deep investigator, Colebrooke, puts Warahamira in the 5th, Brahmagupta in the end of the 6th century, and Aryabhatta, rather uncertainly, between 200 and 400 years after our era. (Compare Holtzmann upon the Grecian origin of the Indian Zodiacal Circle, 1841, p. 23).

150 (p. 219.)—Respecting the reasons which according to the testimony of our text of Strabo, demonstrate the late commencement of the undertaking, *vide* Groskurd's German translation, Pt. i. (1831) p. xvii.

151 (p. 219.)—Strabo, lib. i. p. 14, lib. ii. p. 118, lib. xvi. p. 781, lib. xvii. p. 798 and 815.

152 (p. 219.)—Compare the two passages of Strabo, lib. i. p. 65, and lib. ii. p. 118, (Humboldt, Examen critiq. de l'histoire de la Géographie, vol. i. p. 152—154). In the valuable new edition of Strabo by Gustav Cramer, (1844), Pt. i. p. 100, "for the parallel of Thinæ, the parallel of Athens is read, as if Thinæ was first used in the Pseudo-Arrian, in the *Periplus maris Rubri*." Dodwell places this voyage (*Periplus*) in the time of Marcus Aurelius and Lucius Verus, whilst according to Letronne the work was first written in the time of Septimus Severus and Caracalla. Although five passages in Strabo, according to all manuscripts, have the word Thinæ, yet the expressions in lib. 79, 86, 87 and particularly in p. 82, when Eratosthenes himself is mentioned, allude to the parallel of Athens and Rhodes. The two were confounded together, for the ancient geographers made the peninsula of Attica stretch too far southwards. It must also appear remarkable, even if the reading Θινῶν κύκλος be the correct one, that a certain parallel, *the Diaphragm of*

Dicæarchus should be called after a place so little known as Sinæ (Tsin). Nevertheless Cosmas Indicopleustes also places his *Tzinitza* (Thinæ) in connection with the mountain chain separating the Persian from the Roman territories, and thus dividing the entire world into two parts; he adds the following remark in words which are worthy of notice; "According to the belief of the Indian philosophers or Brahmins." Compare Cosmas in Montfaucon, Collect. nova Patrum, vol. ii. p. 137, and Asie centrale, vol. i. p xxiii. 120—129 and 194—203, vol. ii. p. 413. The Pseudo-Arrian (Agathemeros according to the learned inquiries of Professor Franz) and Cosmas decidedly consider the metropolis of Sinæ to have been in a northern latitude, about the parallel of Rhodes and Athens; whilst Ptolemæus, misled by the accounts of sailors, (Geogr. i. 17), only knew of the existence of Thinæ, three degrees south of the Equator. I suppose that Thinæ merely signified, in general, an emporium of Sinæ, a haven in the land of Tsin, and that therefore a Thinæ may have been mentioned in the north *(Tzinitza)* and another to the south of the Equator.

153 (p. 220.)—Strabo, lib. i. p. 49—60, lib. ii. p. 95 and 97, lib. vi. p. 277, lib. xvii. p. 830. Concerning the elevation of the continents, *vide* particularly lib. i. p. 51, 54 and 59. Even the ancient Eleatic Xenophanes knew by the store of fossil marine productions far away from the coast, "that the present dry land was lifted out of the sea." (Origen. Philosophumena, cap. 4). Appuleius, in the time of Antoninus, collected petrefactions in the Getulian (Mauritanian) mountains, and attributed their existence to Deucalion's flood, which he considered to be equally as general as the Hebrews did that of Noah, and the Mexicans that of Coxcox. The supposition of Beckmann and Cuvier (History of Discoveries, v. ii. p. 370, and Hist. des Sciences nat. vol. i. p. 350) that Appuleius made a collection of natural curiosities, has been disproved by Professor Franz, by very careful investigations.

154 (p. 221.)—Strabo, lib. xvii. p. 810.

155 (p. 221.)—Carl Ritter's Asie, Pt. v. p. 560.

156 (p. 222.)—*Vide* the remarkable examples of mistaken ideas of the position of mountain chains amongst the Romans and Greeks, collected together in the introduction to my 'Asie centrale,' vol. i. p. xxxvii—xl. Respecting the uncertainty of the numerical determinations of localities by Ptolemæus, the most satisfactory special investi-

gations are found in a treatise of Ukert in the 'Rhenish Museum for Philology,' 6th year, 1838, p. 314—324.

[157] (p. 222.)—For examples of Zend and Sanscrit words which have been preserved in the Geography of Ptolemæus, *vide* Lassen, 'Dissert. in Taprobane insula,' p. 6, 9 and 17; in Bournouf's 'Comment. sur le Yaçna,' vol. i. p. xciii—cxx and clxxxi—clxxxv; in my 'Examen critiq. de l'histoire de la Géograph. vol. i. p. 45—49. In some rare instances, Ptolemæus gives the Sanscrit names and their signification at the same time: as the Island of Java, as a Barley-island, Ἰαβαδίου, ὃ σημαίνει κριθῆς νῆσος, Ptol. vii. 2, (William von Humboldt upon the Cawi language, vol. i. p. 60—63). Even at the present day, according to Buschmann, in the principal Indian languages, (the Hindustanee, Bengal and Nepâl, in the Mahratta, Guzerat and Cingalese languages), as well as in Persian and Malay, the double barley (Hordeum distichon) is called *yava*, *dschav* or *dschau*, (*jav* or *jau*), and in Orissa *yaa*. (Compare the Indian translations of the Bible in the passages of John, vi. 9 and 13, and Ainslie's Materia Medica of Hindoostan, Madras, 1813, p. 217).

[158] (p. 223.)—*Vide* my 'Examen crit. de l'hist. de la Géographie,' vol. ii. p. 147—188.

[159] (p. 223.)—Strabo, lib. xi. p. 506.

[160] (p. 224.)—Menander, 'de legationibus Barbarorum ad Romanos et Romanorum ad gentes,' e rec. Bekkeri et Niebuhr, 1829, p. 300, 619, 623 and 628.

[161] (p. 224.)—Plutarch, 'de facie in orbe lunæ,' p. 921, 19. (Compare my 'Examen crit.' v. i. p. 145 and 191). I have myself occasionally encountered, even among very educated Persians, the hypothesis of Agesianax, according to which the spots in the moon, in which Plutarch thought that he recognized a peculiar kind of (volcanic?) luminous mountains, are considered to be merely reflected lands, seas and isthmuses upon our earth. "That which they show us," say they, "through the telescope upon the moon's surface, are reflected images of our earth."

[162] (p. 224.)—Ptolem. lib. iv. c. 9, lib. vii. c. 3 and 5. Compare Letronne, in the 'Journal des Savans,' 1831, p. 476—480 and 545—555; Humboldt's Examen crit. vol. i. p. 144, 161 and 329, vol. ii. p. 370—373.

[163] (p. 225.)—Delambre, 'Hist. de l'Astronomie ancienne,' vol. i. p. liv, vol. ii. p. 551. Theon never mentions the Optics of Ptolemæus, although he lived two entire centuries after him.

[164] (p. 225.)—It is frequently difficult to decide in the physical writings of the ancients, whether a certain result is the consequence of some phenomenon purposely induced, or whether it has been accidentally observed. When Aristotle (de Cœlo, iv. 4) treats of the weight of the atmosphere, which Ideler certainly seems to deny, (Meteorologia veterum Græcorum et Romanorum, p. 23), he says distinctly, "An inflated bladder is heavier than an empty one." The experiment must have been made with condensed air, provided it was really performed.

[165] (p. 225.)—Aristot. de Anima, ii. 7; Biese, "The philosophy of Aristotle, vol. ii. p. 147.

[166] (p. 226.)—Joannis (Philoponi) Grammatici in libr. de generat. and Alexandri Aphrodis. in Meteorol. Comment. (Venet. 1527), p. 97, b. Compare my "Examen Critique," vol. ii. p. 306—312.

[167] (p. 226.)—Metellus, the Numidian, had 142 elephants slain in the Circus. In the games which Pompey made, 600 lions and 406 panthers appeared. Augustus offered up 3,500 wild beasts in the popular shows: and a tender husband complains that he could not celebrate the day of his wife's death by a bloody gladiatorial fight at Verona, "because adverse winds had kept back the panthers, which had been bought in Africa, in the ports!" (Plin. Epist. vi. 34.)

[168] (p. 227.)—Compare above, note 153. Yet Appuleius, as Cuvier records (Hist. des Sciences Naturelles, vol. i. p. 287), first accurately described the bony hooks in the second and third stomachs of the Aplysia.

[169] (p. 230.)—"Est enim animorum ingeniorumque naturale quoddam quasi pabulum consideratio contemplatioque naturæ. Erigimur, elatiores fieri videmur, humana despicimus, cogitantesque supera atque cœlestia hæc nostra, ut exigua et minima, contemnimus." Cicero Acad. ii. 41.

[170] (p. 231.)—Plin. xxxvii. 13, (ed. Sillig, vol. v. 1836, p. 320.) All earlier editions ended with the words Hispaniam, quacunque ambitur mari. The conclusion of the work has been discovered in a Bamberg manuscript, by M. Ludwig von Jan (Professor at Schweinfurt.)

[171] (p. 231.)—Claudian, in Secundum consulatum Stilichonis, v. 150—155.

[172] (p. 232.)—Kosmos, vol. i. p. 391 and 481, and vol. ii. p. 23. (Compare also William von Humboldt, upon the Cawi language, vol. i. p. xxxviii.)

[173] (p. 237.)—If Charles Martell, as has been frequently said, by his

victory at Tours, preserved the centre of Europe against the incursions the Mohammedans, yet we may not suppose, with equal justice, that the retreat of the Mongolians, after the battle at Liegnitz, prevented Buddhism from spreading as far as the Elbe and Rhine. The conquest of the Mongolians, in the plains of Wahlstall, near Liegnitz, in which Duke Heinrich the Pious fell gloriously, took place on the 9th of April, 1241, four years after the period, when, in the time of Batu, the grandson of Tschingiskan, Kaptshak and Russia were overrun by the Asiatic hordes. The first introduction of Buddhism among the Mongolians, falls in the year 1247, when, far in the east, at Leang-tsheu, in the Chinese province of Schensi, the sick Mongolian prince, Godan, sent for Sakya Pandita, a high-priest of Thibet, to be healed and converted by him. (Klaproth, in the manuscript fragment upon the extension of Buddhism in the east and north of Asia. (Moreover, the Mongolians never troubled themselves with attempting to convert the nations whom they had subdued.

[174] (p. 237.)—Kosmos, vol. i. p. 313 and 464.

[175] (p. 239.)—Hence the contrast between the tyrannical regulations of Motewekkil, tenth caliph of the house of the Abbassides, against the Jews and Christians (Joseph von Hammer, upon the management of the countries in the time of the Caliphats, 1835, p. 27, 85 and 117), and the mild toleration under wiser rulers in Spain. (Conde, Hist. de la Dominacion de los Arabes en España, 1820, vol. i. p. 67.) We must also remember, that after the taking of Jerusalem, Omar allowed all the rites of Christian worship, and concluded a treaty with the Patriarch, favourable to the Christians. (Mines of the East, vol. v. p. 68.)

[176] (p. 239.)—"According to tradition, a powerful branch of the Hebrew race, long before the time of Abraham, migrated into southern Arabia, under the name of Jokthan (Quackthan), and there founded a flourishing kingdom." (Ewald, History of the People of Israel, vol. i. p. 337 and 450.)

[177] (p. 240.)—The tree which produced the Arabian frankincense of Hadhramaut, so famous from the most ancient times, has not yet been discovered and determined by any botanist, not even by the painstaking investigator Ehrenberg. The Island of Socotora is altogether without any. There is a similar product in the East Indies, principally in Bundelkhund, with which a considerable trade from Bombay to China is carried on. This Indian incense, according to Colebrooke (Asiatic Researches,

vol. ix. p. 377), has been obtained by a plant known through Roxburgh, the *Boswellia thurifera* or *serrata*, of the family of the *Burseraceæ* of Kunth. Although, from the ancient trading communications between the coasts of south Arabia and western India (Gildemeister, Scriptorum Arabum loci de rebus Indicis, p. 35), there may be some doubt whether the λίβανος of Theophrastus, the *Thus* of the Romans, originally belonged to the peninsula of Arabia; yet Lassen's remark is very important (Indian Antiquity, vol. i. p. 286,) that the frankincense is called in Amara-Koscha, "*yâwana*, Javanese, *i. e.* Arabian," and that it was, therefore, to be considered as a natural production of Arabia, brought to India. "*Turuschka' pindaka' sihlô* (their name for frankincense), *yâwanô*," are the words signifying it in Amara-Koscha. (Amarâkocha publ. par. A. Loiseleur Deslongchamps, pt. i. 1839, p. 156.) Also, Dioscorides distinguishes the Indian frankincense from the Arabian. Carl Ritter, in his splendid monograph upon the species of Frankincense, (Asia, vol. viii. pt. i. p. 356—372), accurately remarks that this species of plant (*Boswellia thurifera*) might, from the resemblance in the climate, have extended from India, through the south of Persia, into Arabia. The American frankincense (*Olibanum Americanum* of our pharmacopeias,) comes from the *Icica guyanensis*, Aubl. and *Icica tacamahaca*, as we (Bonpland and myself), have frequently found it in the vast grassy plains (Llanos) of Calabozo, in South America. *Icica* as well as *Boswellia* is of the family of the *Burseraceæ*. The fir (*Pinus abies* of Linnæus) produces the ordinary incense of our churches. The plants which produce the myrrh, and which Bruce believed that he saw (Ainslie, Materia Medica of Hindoostan, Madras 1813, p. 29), was discovered near El Gisan, in Arabia, by Ehrenberg, and was described by Nees of Esenbeck, from the specimens which he collected, under the name of *Balsamodendron myrrha*. For a long time, the *Balsamodendron Kotaf*, Kunth, an *Amyris* of Forskäl, was falsely considered to have been the tree which produced genuine myrrh.

178 (p. 240.)—Wellsted, Travels in Arabia, 1838, vol. i. p. 272, 289.

179 (p. 240.)—Jomard, Etudes Géograph. et Histor. sur l'Arabie, 1839, p. 14 and 32.

180 (p. 240.)—Kosmos, vol. ii. p. 163.

181 (p. 241.)—Isaiah, ch. lx. v. 6.

182 (p. 242.)—Ewald, History of the People of Israel, vol. i. p. 300 and 450; Bunsen, Egypt, book iii. p. 10 and 32. The traditions of the

Medes and Persians, in northern Africa, indicate the ancient migrations of races of people towards the west. They were connected with the variously formed fable of Hercules, and the Phœnician Melkarth. (Compare Sallust, Bellum Jugurth, cap. xviii, obtained from Punic writings of Hiempsal; Pliny, v. 8.) Strabo, indeed, calls the Maurusians (the inhabitants of Mauritania), "Indians come with Hercules."

183 (p. 243.)—Diod. Sicul. lib. ii. cap. 2 and 3.

184 (p. 243.)—Ctesiæ Cnidii Operum Reliquiæ ed. Baehr; Fragmenta Assyriaca p. 421, and Carl Müller, in Dindorf's edition of Herodotus (Paris, 1844,) p. 13—15.

185 (p. 243.)—Gibbon, History of the Decline and Fall of the Roman Empire, vol. ix. chap. l. p. 200. (Leipsig, 1829.)

186 (p. 244.)—Humboldt, "Asie Centrale," vol. ii. p. 128.

187 (p. 244.)—Jourdain, Recherches Critiques sur l'Age des Traductions d'Aristote, 1819. p. 81, and 87.

188 (p. 248.)—Respecting the knowledge of medicine, which the Arabians acquired from the Indians, *vide* the important investigations of Wilson, in the Oriental Magazine of Calcutta, 1823, Feb. and March, and by Royle, in his "Essay on the Antiquity of Hindoo Medicine," 1837, p. 56—59, 64—66, 73 and 92. Compare a Catalogue of Arabic Pharmaceutical Writings, which are translated out of the Indian in Ainslie. (Madras edition), p. 289.

189 (p. 249.)—Gibbon, vol. ix. chap. li. p. 392; Hereen, History of the Study of Classical Literature, vol. i. 1797, p. 44 and 72; Sacy, Abd-Allatif, p. 240; Parthey's Alexandrine Museum, 1838, p. 106.

190 (p. 250.)—Heinrich Ritter, History of Christian Philosophy, pt. iii. 1844, p. 669—676.

191 (p. 250.)—Reinaud, in three new works, which prove how much may still be attained from Arabian and Persian sources, as well as from Chinese works; "Fragments Arabes et Persans inédits, relatifs à l'Inde, antérieurement au XIe. siècle de l'ère Chrétienne, 1845, p. 20—33;" "Relation des Voyages faits par les Arabes et les Persans dans l'Inde et à la Chine dans le IXe. siècle de notre ère, 1845, vol. i. p. 46;" "Mémoire Géographique et Historique sur l'Inde d'après les écrivains Arabes, Persans et Chinois, antérieurement au milieu du onzième siècle de l'ère Chrétienne," 1846, p. 6. The second work of the learned Oriental scholar, M. Reinaud, is a newly elaborated edition of the imperfect work, "Anciennes Relations des Indes et de la Chine, de deux Voyageurs Ma-

hométans," (1718), published by the Abbé Renaudot. The Arabian manuscript contains only the account of one journey, that of the merchant Soléiman, who embarked, in the year 851, upon the Persian Gulf. To this report is appended the information obtained from other intelligent traders, by Abu-Zeyd-Hassan, of Syraf, in Faristan, who never had travelled to India or China.

[192] (p. 251.)—Reinaud et Favé du feu Grégeois, 1845, p. 200.

[193] (p. 251.)—Ukert upon Marinus Tyrius and Ptolemæus, the Geographers, in the "Rhenish Museum for Philology," 1839, p. 329—332; Gildemeister "de Rebus Indicis," part i. 1838, p. 120; Humboldt "Asie Centrale," vol. ii. p. 191.

[194] (p. 251.)—The "Oriental Geography" of Eben Haukal, which Sir William Ouseley published in London in 1800, is that of Abu-Ishak el-Istachri, and, as Frähn has pointed out, (Ibn Fozlan, p. 9, 22, and 256—263), is half a century older than Abn-Haukal. The charts which accompany the "Book of the Climates." of the year 920, and of which the library at Gotha possesses a beautiful manuscript, have been very useful to me in my works upon the Caspian Sea and the Sea of Aral (Asie Centrale, vol. ii. p. 192—196). We possess a recent edition, and a German translation of Istachri. (Liber Climatum. Ad similitudinem codicis Gothani delineandum cur. J. H. Mœller, Goth 1839. The "Book of the Lands," translated from the Arabic, by A. D. Mordmann, Hamburgh, 1845.)

[195] (p. 251.)—Compare Joaquim José da Costa de Macedo, Memoria em que se pretende provar que os Arabes não conhecerão as Canarias antes dos Portuguezes (Lisboa, 1844), p. 86—99, 205—227, with Humboldt, Examen. Crit. de l'Hist. de la Géogr. vol. ii. p. 137—141.

[196] (p. 252.)—Leopold von Ledebur, upon the proofs of commercial intercourse with the east, in the time of the Arabian dominion, found in the countries bordering the Baltic (1840), p. 8 and 75.

[197] (p. 252.)—The determinations of the longitude, which Abul-Hassan Ali, of Morocco, an astronomer of the 13th century, incorporated in his work upon the astronomical instruments of the Arabians, are all reckoned according to the first meridian of Arin. M. Sedillot (fils) first directed the attention of geographers to this meridian. It must, however, have become an object of very careful research, for Christopher Columbus, led, as usual, by the *Imago Mundi* of Cardinal d'Ailly, mentions an *Isla de Arin* in his fanciful ideas concerning the inequality of the earth's shape

in the eastern and western hemispheres; "Centro de el hemispherio del qual habla Toloméo y quès debaxo la linea equinoxial entre el Sino Arabico y aquel de Persia. (Compare J. J. Sédillot, "Traité des Instruments astronomiques des Arabes, publié par L. Am. Sédillot, vol. i. 1834, p. 312—318: vol. ii. 1835, preface, with Humboldt, Examen Crit. de l'Hist. de la Géograph. vol. iii. p. 64, and Asie Centrale, vol. iii. p. 593—596, where the opinions are found which I discovered in the *Mappa Mundi* of Alliacus, of 1410, in Alphonso's tables of 1483, and in Madrignano's "Itinerarium Portugallensium," of 1508. It is wonderful that Edrisi appears to know nothing of Khobbet Arin (Cancadora, or properly, Kankder). Sédillot Jun. (in Mémoire sur les systèmes Géographiques des Grecs et des Arabes, 1842, p. 20—25), places the meridian of Arin in the groupe of the Azores, whilst the learned Commentator of Abulfeda, M. Reinaud (Mémoire sur l'Inde antérieurement au xie. siècle de l'ère chrétienne, d'après les écrivains Arabes et Persans, p. 20—24), supposes "that *Arin* arose out of confusion with *azyn*, *ozein*, and *Odjein*, the name of an ancient place of worship (according to Burnouf, *Udjijayani*) in Malva, Ὀζήνη of Ptolemæus. This Ozene lies in the meridian of Lanka, and, in after-times, Arin was taken for an island on the coast of Zanguebar, perhaps Ἔσσυνον of Ptolemæus". Compare also, Am. Sédillot, Mém. sur les Instr. Astron. des Arabes, 1841, p. 75.

[193] (p. 252.)—The Caliph Al Mamun, had numerous precious Greek manuscripts bought up in Constantinople, Armenia, Syria, and Egypt, and transcribed at once from the Greek into the Arabic, whilst, before his time, the Arabic translations were made from Syrian translations. (Jourdain, Recherches Critiques sur l'âge, et sur l'origine des traductions latines d'Aristote, 1819, p. 85, 88, and 226.) Thus, many things were preserved by the exertions of Al Mamum, which without the Arabians, would have been altogether lost. It has been recently shown by Neumann of Munich, that the Armenian translations performed a similar service. We may certainly suppose, from a notice of the historian Genzi, of Bagdad, preserved by the famous geographer, Leo Africanus, in a work "De viris inter Arabes illustribus," that many Greek original manuscripts, considered to be useless, were burnt at Bagdad; but the passage does not refer to important manuscripts which had been previously translated. It is capable of several explanations, as Bernhardy ("Sketch of Grecian Literature," pt. i. p. 489), showed, in opposition to Heeren's History of Classical Literature (vol. i. p. 135). The Arabic

translations frequently assisted in making the Latin translations of Aristotle, (for instance, the eight books of the *Physica* and the *History of animals*), yet the greater and best part of the Latin translations, were made immediately from the Greek. (Jourdain. Rech. Crit. sur l'âge des traductions d'Aristote, p. 230—236.) We learn this double source also from the memorable letter with which the Emperor Frederic II. of the Hohenstaufens sent, in the year 1232, translations of Aristotle's works to his universities, especially to Bologna. This letter bears the impress of an elevated genius; it shows that it was not only love of natural history which taught Frederic II. to prize philosophy; "Compilationes varias quæ ab Aristotele aliisque philosophis sub græcis arabicisque vocabulis antiquitus editæ sunt." "We have aimed at wisdom from our earliest youth, although the cares of the government have abstracted us from it; we employed our time with pleasure and earnestness, in reading noble works, that the mind may become clearer and stronger by acquisitions, without which the life of man is devoid of regularity and freedom. (ut animæ clarius vigeat instrumentum in acquisitione scientiæ, sine qua mortalium vita non regitur liberaliter). Libros ipsos tamquam præmium amici Cæsaris gratulanter accipite, et ipsos antiquis philosophorum operibus, qui vocis vestræ ministerio reviviscunt, aggregantes in auditorio vestro. . . . (Compare Jourdain, p. 169—178, and Friedrich von Raumer's splendid "History of the Family of the Hohenstaufens," vol. iii. 1841, p. 413.) The Arabians have appeared as a connecting link between ancient and modern science. Without their aid, and their desire for translations, the following centuries would have lost the greater part of the productions of the Grecian world. According to this view, the relations, apparently connected with the languages only, which we have here touched upon, obtain an universal interest.

199 (p. 252.)—The translation of Aristotle's "Historia Animalium," by *Michael Scotus*, and of a similar work by Avicenna (Manuscripts of the Parisian Library, No. 6493), will be found noticed in Jourdain's "Traductions d'Aristote," p. 135—138, and Schneider, Adnot. ad Aristotelis de Animalibus hist. lib. ix. cap. 15.

200 (p. 252.) Concerning Ibn-Baithar, *vide* Sprengel, History of Medicine, pt. ii. (1823,) p. 468, and Royle on the Antiquity of Hindoo Medicine, p. 28. We have possessed, since 1840, a German translation of Ibn-Baithar, entitled, "Grand comparison of the strength of the

known simple medicinal and nutritious Articles," translated from the Arabic, by J. von Sontheimer, 2 vols.

[201] (p. 253.)—Royle, p. 35—65. Susruta, son of Visvamitra, is considered, by Wilson, to be a cotemporary of Rama. We have a Sanscrit edition of his works. (The Sus'ruta, or System of Medicine, taught by Dhanwantari, and composed by his disciple Sus'ruta. Ed. by Sri Madhusúdana Gupta, vol. i. ii. Calcutta, 1835, 1836), and a Latin translation; Sus'rutas, Ayurvédas. Id est Medicinæ Systema, a venerabili D'hanvantare demonstratum, a Sus'ruta discipulo compositum. Nunc primum ex Sanskrita in Latinum sermonem vertit Franc. Hessler. Erlangæ 1844, 1847, 2 vols.

[202] (p. 253.)—*Deiudar* (*deodar*), of the genus of *abhel* (juniperus); also Indian fir, which gives a peculiar milk, *syr deuidar* (fluid turpentine), Avicenna.

[203] (p. 253.)—Spanish Jews from Cordova brought the doctrines of Avicenna to Montpellier, and chiefly contributed to endow this distinguished medical school, which was founded after an Arabic pattern, and dates at about the 12th century. (Cuvier, Hist. des Sciences Naturelles vol. i. p. 387).

[204] (p. 253.)—Concerning the gardens in the palace of Rissafah, which Abdurrahman Ibn-Moawijeh founded, *vide* History of the Mohammedan Dynasties in Spain, extracted from Ahmed Ibn-Mohammed Al-Makkari by Pascual de Gayangos, vol. i. 1840, p. 209—211. "En su Huerta plantó el Rey Abdurrahman una palma que era entonces (756) unica, y de ella procediéron todas las que hay en España. La vista del arbol acrecentaba mas que templaba su melancolia." (Antonio Conde, Hist. de la dominacion de los Abrabes en España, t. i. p. 169).

[205] (p. 254.)—The preparation of nitric acid and aqua regia, by Jaber (properly Abu-Mussah Jafar), is more than 500 years before the time of Albert the Great and Raymund Lullus, and almost 700 years before the time of the Monk of Erfurt, Basilius Valentinus. Yet, for a long time, the epoch of the discovery of these decomposing acids was referred to the age of these three natural philosophers.

[206] (p. 254.)—Concerning the fermentation of amylaceous substances and sugar, and the distillation of alcohol, *vide* Hoefer, Hist. de la Chemie, vol. i. p. 325. And when Alexander of Aphrodisias (Johannis Philoponi Grammatici in libr. de generatione et interitu Comm. Venet. 1527, p. 97,)

is describing circumstantially merely the distillation of sea-water, he mentions, at the same time, that wine may also be distilled. This supposition of his is more remarkable, because Aristotle brought forward the erroneous opinion, that by natural evaporation, only fresh water passes away from wine (Meteorolog. ii. 3, p. 358, Bekker), as out of the salt water of the sea.

207 (p. 255.)—The chemistry of the Indians, including the art of the Alchemists, is called, *rasâyana* (*rasa*, juice, fluid, and also quicksilver, and *âyana*, course), and forms, according to Wilson, the seventh section of the *Ayur-Veda*, the science of life, or of lengthening life (Royle, Hindoo Medicine, p. 39—48). The Indians, from the earliest times, (Royle p. 131), were acquainted with the application of *aqua fortis*, in pressing calico or cotton-cloth, an Egyptian art which is found most clearly described in Pliny, lib. xxxv. cap. ii. No. 150. The name "Chemistry," means literally, "Egyptian art," "The Art of the Black Land;" for even Plutarch (De Iside et Osir, cap. 33), knew that the Egyptians called their land Χημία on account of the black coloured earth. The inscription in the Rosetta stone has "Chmi." The word Chemistry, in its usual sense, is first found in the decree of Dioclesian, "Against the old writings of the Egyptians, which treat of the Chemistry of gold and silver (περὶ χημίας ἀργύρου καὶ χρυσοῦ);" compare my "Examen Critique de l'hist. de la Géographie et de l'Astronomie Nautique, vol. ii. p. 314.

208 (p. 255.)—Reinaud et Favé du feu grégeois, des feux de guerre et des origines de la poudre à canon, in their Histoire de l'Artillerie, vol. i. 1845, p. 89—97, 201 and 211; Piobert, Traité d'Artillerie, 1836, p. 25; Beckmann, Technologie, p. 342.

209 (p. 256.)—Laplace, Précis de l'hist. de l'Astronomie, 1821, p. 60, and Am. Sédillot, Mémoire sur les Instruments Astron. des Arabes, 1841, p. 44. Also, Thomas Young (Lectures on Natural Philosophy, and the Mechanical Arts, 1807, vol. i. p. 191,) does not doubt that Ebn-Junis used the pendulum in the end of the 10th century, for the measurement of time; but the connection of the pendulum with wheel-works, is first ascribed to Sanctorius (1612, and therefore, forty-four years before Huygens.) With respect to the very ingenious clock which was among the presents sent by Haroun Al-Raschid, or rather by the Caliph Abdallah, from Persia, to the Emperor Charlemagne, at Aix-la-Chapelle, two centuries earlier (807), Eginhard says distinctly, that it was moved by water ("Horologium ex aurichalco arte mechanica mirifice compo-

situm, in quo duodecim horarum cursus ad clepsidram vertebatur); Einhardi Annales in Pertz, Monumenta Germaniæ Historica, Scriptorum vol. i. 1826, p. 195. Compare H. Mutius de Germanorum origine, gestis, &c. Chronic. lib. viii. p. 57, in Pistorii Germanicorum Scriptorum, vol. ii. Francof, 1584; Bouquet Receuil des Historiens des Gaules, vol. v. p. 333 and 354. The hours were struck by means of sounds produced by the falling of little balls, and by the appearance of little knights from an equal number of little doors. The mode by which the water worked in these clocks, may have been different among the Chaldeans, "who weighed time," (*i. e.* determined it by the weight of fluid), and the Greeks and Indians in the Clepsydræ; for the hydraulic clockwork of Ctesibius (in the time of Ptolemy Evergetes II.), which told the time to all the citizens, throughout the year, in Alexandria, according to Ideler, (Handbook of Chronology, 1825, vol. i. p. 231), does not come under the general term *κλεψύδρα*. According to the description of Vitruvius (lib. ix. cap. 4), it was a real astronomical clock, *horologium ex aqua*, and very complex *machina hydraulica*, working by means of toothed-weels (versatilis tympani denticuli æquales alius alium impellentes). It is, therefore, not improbable, that the Arabs, being acquainted with all the improvements in mechanical apparatus made in the time of the Roman empire, had constructed an hydraulic clock, working with wheels (tympana quæ nonnulli rotas appellant, Græci autem *περίτροχα*. Vitruv, x. 4). Leibnitz, however, (Annales Imperii occidentis Brunsvicenses, ed. Pertz, vol. i. 1843, p. 247), expresses his astonishment at the construction of the clock of Haroun Al-Raschid. (Abd-Allatif, trad. par Silvestre de Sacy, p. 578). The mechanical apparatus which the Sultan of Egypt sent in 1232 to the Emperor Frederic II. was much more remarkable. It was a great tent, in which the sun and moon, moved by mechanical contrivances, rose and set, and pointed out the hours of the day and night, at the proper intervals. In the "Annales Godefridi Monachi, S. Pantaleonis apud Coloniam Agrippinam," it is called, "Tentorium in quo imagines Solis et Lunæ artificialiter motæ cursum suum certis et debitis spaciis peragrant et horas diei et noctis infallibiter indicant," (Freheri rerum Germanicarum Scriptores, vol. i. Argentor, 1717, p. 398.) The monk Godefridus, or any other of the numerous authors, who probably preserved an account of these years in the Chronicle kept at Cologne, in the monastery of St. Pantaleon (*vide* Böhmer, Fontes rerum Germanicarum, vol. ii. 1845, p. xxxiv.—xxxvii.), lived in the time of the great Emperor, Frederic II. The

Emperor had the machine, which was valued at 20,000 marks, kept at Venusium, among other treasures (Fried. v. Raumer, History of the Hohenstaufens, vol. iii. p. 430). It has frequently been supposed, that the entire tent moved like the sky, but this is to me exceedingly improbable. In the "Chronica Monasterii Hirsaugiensis," which Trithemius edited, the passage from the "Annales Godefridi" is merely repeated, without containing any further information respecting the mechanism of the apparatus (Joh. Trithemii Opera Historica, P. ii. Francof. 1601, p. 180.) Reinaud says, The motion was effected, "par des ressorts cachés." (Extraits des Historiens Arabes relatifs aux guerres des Croisades, 1829, p. 435.)

210 (p. 257.)—Concerning the Indian tables, which Alphazari and Alkoresmi translated into Arabic, *vide* Chasles, Recherches sur l'Astronomie Indienne, in the Comptes rendus des Séances de l'Acad. des Sciences, vol. xxiii. 1846, p. 846—850. The substitution of the *sine* for the arc, which is generally ascribed to Albategnius, in the beginning of the 10th century, existed originally among the Indians; tables of the *sines* are found in the *Surya-Siddhanta.*

211 (p. 257.)—Reinaud, Fragments Arabes relatifs à l'Inde, p. xii.—xvii., 96—126, and more particularly 135—160. Albyruni's proper name was Abul-Ryhan. He was born at Byrun, in the valley of the Indus, was a friend of Avicenna, and lived with him in the Arabian academy, which was established in Charezm. His abode in India, and the composition of his History of India (*Tarikhi-Hind,*) the most important fragments of which have been made known by Reinaud, occurred in the years 1030—1032.

212 (p. 258.)—Sédillot, Matériaux pour servir à l'Histoire comparée des Sciences Mathématiques, chez les Grecs et les Orientaux, vol. i. p. 50—89. and the same author, in the Comptes rendus de l'Academie des Sciences, vol. ii. 1836, p. 202; vol. xvii. 1843, p. 163—173; vol. xx. 1845, p. 1308. In opposition to this opinion, M. Biot supposes that the beautiful discovery of Tycho by no means belongs to Abul-Wefa, that the latter did not know the *variation*, but only the second part of the *évection*; *vide* Journal des Savants, 1843, p. 513—532, 609—626, 719—737; 1845, p. 146—166, and Comptes rendus, vol. xx. 1845, p. 1319—1323.

213 (p. 258.)—Laplace, Expos. du Système du Monde, note v. p. 407.

214 (p. 259.)—Respecting the observatory of Meragha, *vide* Delambre,

Histoire de l'Astronomie du moyen âge, p. 198—203, and Am. Sédillot, Mém. sur les Instr. Arabes, 1841, p. 201—205, where the Gnomon is described with a circular aperture; respecting the peculiarity of the Catalogue of the Stars by Ulugh Beig, *vide* J. J. Sédillot, Traité des Instruments Astron. des Arabes, 1834, p. 4.

[215] (p. 259.)—Colebrooke, " Algebra with Arithmetic and Mensuration, from the Sanscrit of *Brahmegupta* and *Bhascara*. Lond. 1817; Chasles, Aperçu Historique sur l'origine et le développement des Méthodes en Géométrie, 1837, p. 416—502; Nesselman, " Attempt at a Critical History of Algebra," pt. i. p. 30—61, 273—276, 302—306.

[216] (p. 259.)—Algebra of Mohammed ben Musa, edited and translated by F. Rosen, 1831, p. viii. 72 and 196—199. The mathematical knowledge of the Indians also extended itself into China, about the year 720; but this was at a time, when already many Arabians were settled in Canton and other Chinese towns; Reinaud, Rélation des Voyages fait par les Arabes dans l'Inde et à la Chine, vol. i. p. cix: vol. ii. p. 36.

[217] (p. 260.)—Chasles, Histoire de l'Algèbre in the 'Comptes rendus,' vol. xiii. 1841, p. 497—524, 601—626; Compare also, Libri, in the same work, p. 559—563.

[218] (p. 261.)—Chasles, Aperçu Historique des Méthodes en Géométrie, 1837, p. 464—472; and in the Comptes rendus de l'Academie des Sciences, vol. viii. 1839, p. 78; vol. ix. 1839, p. 449; vol. xvi. 1843, p. 156—173, and 218—246; vol. xvii. 1843, p. 143—154.

[219] (p. 261.)—Humboldt upon the systems of Numbers employed by different nations, and the origin of position employed in the Indian figures, in Crelle's Journal for pure and mixed Mathematics, vol. iv. (1829), p. 205—231; compare also my " Examen Critiq. de l'Hist. de la Géographie," vol. iv. p. 275. " In the simple narrative of the various methods used by nations unacquainted with the method by position, and in expressing the *multipla* of the fundamental modes, will be found, according to my belief, an explanation of the gradual establishment of the Indian system. If we express the number 3568, perpendicularly or horizontally, by means of the *indicators*, which correspond to the different divisions of the Abacus (thus $\overset{3}{\text{M}}.\ \overset{5}{\text{C}}.\ \overset{6}{\text{X}}.\ \overset{8}{\text{I}}.$) we easily recognize that the signs M, C. . . ., may be omitted. Our Indian numbers are nothing more than these indicators; they are the multiplicators of the different groups. By this mode of reckoning by the indicators, we are reminded of the old Asiatic *suanpan* (a counting machine, introduced by the Mon-

golians into Russia), with consecutive rows of strings, for the thousands, hundreds, tens and units. These strings, according to the example adduced above, would present 3, 5, 6, and 8 balls. In the *suanpan*, no groups of figures are visible; they are the places themselves, and these places (strings) are filled up with digits (3, 5, 6 and 8), as multiplicators or indicators. In both ways, by arithmetic *with figures*, (by writing) and by the *palpable* method, (by touching), the method of position, or the value of figures according to position, and the simple use of the nine digits was attained. If the string is empty, the place in writing is empty; if one group of signs is wanting (one step in the progression), the empty space is in writing represented by the hieroglyphic of emptiness, (*súnya, sifron, tzüphra*). In the *method of Eutocius*, I find, in the place of "tens of thousands," the first trace of the *exponential*, or rather the *indicator* system, among the Greeks, which was of so great importance for the East. Mα, Mβ, Mγ, mean 10,000, 20,000, 30,000. The plan used in this way with the "tens of thousands," among the Chinese and the Japanese, who obtained their civilized habits from the Chinese, 200 years before our era, runs through all the *multipla* of the different places. In Gobar, the Arabic sand-writing, which was discovered by my deceased friend and tutor Silvestre de Lacy, in a manuscript from the library of the ancient abbey of St. Germain des Prés, figures are *points*, or *nought*; for in India, Thibet and Persia, noughts and points are identical. In the Gobar 3· is written, instead of 30; 4·· instead of 400; 6.·. instead of 6000. The Indian numbers and the knowledge of position, must be more recent than the separation of the Indians and Arians, for the Zendish people made use of the unserviceable Pehlwi-numbers. The *Tamul* figures appear to me particularly to indicate a *successive* perfection of calculation in India, for by the nine digits, in the place of units, and by particular marks for tens, hundreds, and thousands, all numbers are expressed, the multiplicators being added to the left hand. Also the remarkable *ἀριθμοὶ ἰνδικοί*, from a scholium of a monk, Neophytus, discovered in the Paris Library by Professor Brandis, and kindly communicated to me for publication, help to prove that the system was brought to perfection by degrees. The nine figures of Neophytus, are, except the "4," quite like the present Persian numbers; but the nine figures representing the place of "units," were multiplied, ten, a hundred, or a thousand times, by writing over them one, two, or three "noughts:" thus, $\overset{0}{2}$ for 20, $\overset{0}{2}4$ for 24, and then by

juxta-position, $\overset{oo}{5}$ for 500, $\overset{oo}{36}$ for 306. If, instead of the "noughts," we imagine merely points, we have the Arabic sand-writing, Gobar. Thus, as my brother William von Humboldt has very frequently said, the word "Sanscrit," is used in a very indeterminate way, to mean the Indian, or ancient Indian language, because, upon the Peninsula of India, there are numerous very old languages, not at all allied to the Sanscrit; thus in the same way, the expression, "Indian," or "Ancient Indian numbers," is, in general, very undecided; and this want of precision alludes as well to the form of the figures as to the spirit of the plan, which, at one time depends upon mere *juxta-position,* at another, upon *co-efficients* and *indicators,* and at another, upon the expressions of the value, according to position. Even the existence of the "nought" (0), as the Scholium of Neophytus proves, is no necessary proof of the recognition of simple position in reckoning by Indian figures. The Indians, who speak *Tamul,* have figures apparently distinct from their alphabet, of which the "2" and "8" have a faint resemblance to the Devanagari figures of 2 and 5 (Robt. Anderson, Rudiments of Tamul Grammar, 1821, p. 135); and yet a close comparison indicates that the Tamul cyphers are derived from the alphabetical Tamul writing. The Cingalese figures are also very different from the Devanagari figures. In the Cingalese, and in the Tamul writing, we find no difference of the value according to position, and no nought (0), but hieroglyphics for the places of tens, hundreds, and thousands. The Cingalese, like the Romans, work by *juxta-position,* the Tamuls by *co-efficients.* The real cipher, 0, as something wanting, is used by Ptolemæus, in the Almagest, and in his Geography, in representing the decreasing scale of degrees and numbers. Hence, the "0," is more ancient in the West than the invasion of the Arabs." (*Vide* my treatise, alluded to above, and printed in Crelle's Mathematical Journal, p. 215, 219, 223, 227.)

220 (p. 262.)—William von Humboldt, upon the Cawi language, vol. i. p. 262. Compare also, the splendid delineation of the Arabs, in Herder's Ideas on the History of Man, book xix. 4 and 5.

221 (p. 265.)—Compare Humboldt's Examen. Crit. de l'Hist. de la Géographie, vol. i. p. viii. and xix.

222 (p. 267.)—Parts of America were seen, but not touched at, fourteen years before Leif Eirekson, in the voyage which Bjarme Herjulfson undertook, in the year 986, southward from Greenland. He first saw the land in the island of Nantucket, one degree south of Boston, then in New

Scotland, and lastly, in Newfoundland, which was afterwards called "Little Helluland," but never "Winland." The bay which divides Newfoundland from the mouth of the great river St. Lawrence, was called by the Normans settled in Iceland and Greenland, "Markland's Bay." *Vide* Caroli Christiani Rafn, Antiquitates Americanæ, 1845, p. 4, 421, 423 and 453.

223 (p. 267.)—Gunnbjörn was driven away, in the year 876, or 877, to the point called after him, "Gunnbjörn's Rock," which Captain Graah recently discovered again. He first saw the east coast of Greenland, without landing there (Rafn. Antiq. Amer. p. ii. 93 and 304).

224 (p. 268.)—Kosmos, vol. ii. p. 159.

225 (p. 268.)—These average temperatures of the year in America, on the eastern coast, between the parallels of 42° 25′ and 41° 15′, correspond in Europe to the latitude of Berlin and Paris, and thus to places eight or ten degrees more to the north. In addition to this, the decrease in the average annual temperature on the western coast of North America, from the lower to the more northern latitudes, is so rapid, that in the difference between Boston and Philadelphia (2° 41′), each degree of latitude causes a decrease in temperature of nearly 2° of the centigrade thermometer, whilst, in the system of the isorthermal lines in Europe, the decrease of annual average temperature, according to my investigations, scarcely amounted to half a degree, in the same distance. (Asie centrale, vol. iii. p. 227.)

226 (p. 269.)—*Vide* Carmen Færöicum in quo Vinlandiæ mentio fit. (Rafn, Antiq. American. p. 320 and 332.)

227 (p. 269.)—The Runic Stone was placed upon the highest part of the island Kingiktorsoak. "Upon the Saturday before the day of victory," *i. e.* before the 21st of April, a heathen grand feast of the ancient Scandinavians, which was changed into a Christian feast when they embraced Christianity; Rafn, Antiq. Amer. p. 347—355. Respecting the doubt in the Runic numbers, which Brynjulfsen, Mohnike, and Klaproth have expressed, *vide* my "Examen Critiq." vol. ii. p. 97—101: yet Brynjulfsen and Graah, from other indications, consider the important monument upon "Woman's Islands" (like the Runic inscriptions found at Igalikko and Egegeit, lat. 60° 51′, and 60° 0′, and the ruins of the buildings of Upernavick, lat. 72° 50′) to belong decidedly to the 11th and 12th centuries.

228 (p. 269.)—Rafn, Antiq. Amer. p. 20, 274. and 415—418. (Wilhelmi

upon Iceland, Hvitramannaland, Greenland, and Vinland, p. 117—121) According to a very old tradition, the north-east coast of Greenland was visited, in 1194, under the name of Svalbard, in a region corresponding to the land of Scoresby; near to the point, where my friend, at that time Captain, Sabine, made his observations on the pendulum, and where I (73° 16′) possess a very inhospitable promontory. Rafn, Antiq. Amer. p. 303, and Aperçu de l'ancienne Géographie des régions arctiques de l'Amerique, 1847, p. 6.

[229] (p. 270.)—Wilhelmi, Op. Cit. p. 226; Rafn, Antiq. Americ. p. 264 and 453; the settlements on the west coast of Greenland, which were in a very flourishing condition until the middle of the 14th century, gradually declined from the fatal influence of monopoly of trade, by the invasion of the Esquimaux (Skrälings), by the black death, which according to Hecker, depopulated the north, from the year 1347 to 1351, and also by the arrival of a hostile fleet, from what country it is not known. In the present day we no longer believe in the meteorological fable of a sudden change of climate, and of the formation of a vast collection of ice, which was followed by the entire separation of the colonists settled in Greenland from their mother-country. As these colonies were only formed in the temperate regions of the western coast of Greenland, a Bishop of Skalholt could not have seen, in the year 1540, upon the other side of the wall of ice, "sheep and the shepherds tending them." The collection of the masses of ice on the eastern coast, over against Iceland, depends upon the form of the land, the vicinity of a chain of mountains parallel to the direction of the coast, intersected with glaciers, and the direction of the currents of the ocean. This condition of affairs does not refer to the conclusion of the 14th, or the beginning of the 15th century. It was, as Sir John Barrow has very correctly related, exposed to many accidental changes, especially in the years 1815—1817. (*Vide* Barrow, Voyages of Discovery within the Arctic Regions, 1846, p. 2—6.) Pope Nicholas V. nominated a Greenland Bishop as early as 1448.

[230] (p. 270.)—The principal sources of information are the historical narrations of Erik the Red, Thorsinn Karlsefne, and Snorre Thorbrandson, probably written in Greenland itself, as early as the 12th century, partly by descendents of the settlers, born in Winland; Rafn, Antiquit. Amer. p. vii, xiv, and xvi. The care with which the tables of their pedigrees were kept, was so great, that the table of the family of Thorfinn

Karlsefne, whose son, Snorre Thorbrandsson, was born in America, was kept from the year 1007 to 1811.

[231] (p. 271.) Hvitramannaland, the land of white men. Compare the inquiries in Rafn, Antiq. Amer. p. 203—206, 211, 446—451, and Wilhelmi, upon Iceland, Hvitramannaland, &c. p. 75—81.

[232] (p. 272.)—Letronne, Recherches Géogr. et Crit. sur le livre *de Mensura Orbis Terræ*, composé en Irelande par Dicuil, 1814, p. 129—146. Compare my "Examen Critique de l'Histoire de la Géograph. vol. ii. p. 87—91.

[233] (p. 272.)—I have collected together in an Appendix to the ninth book of my travels (Relation Historique, vol. iii. 1825, p. 159), all the ables that have been spread abroad since Raleigh's time, concerning the inhabitants of Virginia, who spoke the pure Celtic dialect, and how they thought that they heard there the Gaelic salutation, *Hao, hui, iach*, and how Owen Chapelain (1669) saved himself from the hands of the Tuscarores, who were about to scalp him, "by speaking to them in his Gaelic mother-tongue." These Tuscarores, in North Carolina, are a race of the Iroquois, as has been clearly proved by an examination of their language; *vide* Albert Gallatin, on Indian Tribes, in the "Archæologia Americana, vol. ii. (1836), p. 23 and 57. Catlin, one of the most careful observers of habits that has ever lived among the American aborigines gives a considerable collection of Tuscarora words. But he is inclined to consider the fair, and frequently blue-eyed, nation of the Tuscarores to be a mixed race, between the ancient Welsh and the American aboriginal tribes. *Vide* his Letters and Notes on the manners, customs, and condition of the North American Indians, 1841, vol. i. p. 207; vol. ii. p. 259 and 262—265; another collection of Tuscarora words is to be found in manuscript work upon languages, by my brother, in the Royal Library a Berlin. "Comme la structure des idiomes Americains paraît singulièrement bizarre aux différens peuples qui parlent les langues modernes de l'Europe occidentale et se laissent facilement tromper par de fortuites analogies de quelques sons, les théologiens ont cru généralement y voir de l'Hebreu, les colons Espagnols du Basque, les colons Anglais, ou Français du Gallois, de l'Irlandais ou du Bas-Breton. . . . . J'ai rencontré un jour, sur les côtes du Pérou, un officier de la marine Espagnole, et un baleinier Anglais, dont l'un prétendait avoir entendu parler Basque à Tahiti, et l'autre gale-Irlandais aux îles Sandwich." Humboldt, Voyage aux Régions équinoxiales, Relat. Hist. vol. iii. 1825, p. 160. But although

hitherto no connection of the languages has been proved, yet I will by no means deny that the Basques, and the Celtic aborigines of Ireland and Wales, continually occupied upon the distant coasts with fishing, were opponents of the Scandinavians in the northern part of the Atlantic Ocean, and that the people from Ireland may have arrived at the Färöer Islands and Iceland before the Scandinavians. It is much to be wished, that in our days, when a healthy tone of criticism is very much in use, without assuming a scornful character, the ancient inquiries of Powel and Richard Hakluyt (Voyages and Navigations, vol. iii. p. 4) might again be taken up in England, and even in Ireland. Is it proved that Madoc's wandering voyage was celebrated in the poem of the Welsh bard, Mereditho, fifteen years before Columbus' discovery? I do not participate in the notion of rejecting inquiries, by which the traditions of nations are frequently obscured; I prefer much to hold the firm conviction that, with more diligence and perseverance, many of the historical problems which have hitherto remained altogether unknown to us, will, one day, be cleared up by actual discoveries; these historical problems refer to the voyages of the earliest part of the Middle Ages, to the striking agreement in the religion, traditions, divisions of time, and works of art in America and Eastern Asia, to the migrations of the Mexican nations to that ancient central point of concentrated civilization in Aztlan, Quivira, and the Upper Louisiana, as well as in the plains of Cundinamarca and Peru. *Vide* my Examen Crit. de l'hist. de la Géogr. du Nouveau Continent, vol. ii. p. 142—149.

[234] (p. 274.)—Whilst this circumstance of a freedom from ice, in February 1477, is brought forward as a proof that the island Thyle of Columbus cannot be Iceland, Finn Magnusen has discovered, from ancient records, that, until March 1477, the northern part of Iceland had no snow, and that, in February of the same year, the southern coast was free from ice; Examen Crit. vol. i. p. 105; vol. v. p. 213. It is very remarkable, that Columbus, in the same work, "Tratado de las cinco zonas habitables," mentions a southern island, Frislanda; a name which plays a considerable part in the travels of the Brothers Zeni, generally looked upon as fabulous (1388—1404), but which is wanting in the chart of Andrea Bianco (1436), as well as in that of Fra Mauro (1457—1470). Compare "Examen Crit." vol. ii. p. 114—126). Columbus could not have known the voyages of the "Fratelli Zeni," for they were unknown until the year 1558 to the Venetian family, and then they were

published by Marcolin, fifty-two years after the death of the great admiral. Whence comes the acqaintance of the admiral with the name "Frislanda?"

[235] (p. 275.) *Vide* the proofs which I have collected from safe documents, for Columbus, in the "Examen Crit. vol. iv. p. 233, 250 and 261, and for Vespucci, vol. v. p. 182—185. Columbus was so filled with the notion that Cuba was part of the continent of Asia, the south of Khatai (the province of Mango), that he made all the men of his crew (about eighty sailors), swear, upon the 12th of June, 1494, "that they were convinced of the possibility of going from Cuba to Spain by land (que esta tierra de Cuba fuese la tierra firme al comienzo de las Indias, y fin à quien en estas partes quisiere venir de España por tierra"); "Whoever of these who swore, dared to suppose the contrary, should have to expiate his perjury with one hundred stripes, and having the tongue torn out," (*Vide* Informacion del escribano publico Fernando Perez de Luna, in Navarrete, Viages y descubrimientos de los Españoles, vol. ii. p. 143—149.) When Columbus, upon his first expedition, approached the island of Cuba, he believed that he was opposite the Chinese trading cities of Zaitun and Quinsay (y es cierto, dice el Almirante, questa es la tierra firma y que estoy, dice él, ante Zayto y Guinsay.) "He wished to deliver the letter of the Catholic monarch to the great Mongolian Khan (*Gran Can*) in Khatin, and when he had completed the commission assigned to him, to return at once to Spain (but by sea). Afterwards, he sends on shore a baptized Jew, Luis de Torres, because he understood Hebrew, Chaldean, and some Arabic," languages commonly in use in the Asiatic trading places, (*vide* the Journal of the Voyages of Columbus of 1492, in Navarrete, Viages y descubrim. vol. i. p. 37, 44 and 46). Even in 1533, the astronomer Schoner supposes that the whole so-called New World, is a part of Asia (superioris Indiæ), and that the city of Mexico, overcome by the Cortes (Temistitan), is nothing more than the Chinese trading city of Quinsay, rendered so famous by Marco Polo. (*Vide* Joannis Schoneri Carlostadii Opusculum geographicum, Norimb. 1533, pt. ii. cap. i. 20.)

[236] (p. 276.)—Da Asia de João de Barros e de Diogo de Couto, Dec. i. lib. iii. cap. 11. (Parte i. Lisboa, 1778, p. 250).

[237] (p. 278.)—Jourdain, Rech. Crit. sur les traductions d'Aristote, p. 230, 234 and 421—423; Letronne, des opinions cosmographiques

des Pères de l'Eglise, rapprochées des doctrines philosophiques de la Grèce, in the "Revue des deux Mondes," 1834, vol. i. p. 632.

[238] (p. 279.)—Friedrich von Raumer, upon the philanthropy of the 13th century, in his "Historical Pocket Book," 1840, p. 468. Respecting the inclination to adopt Plato's views in the Middle Ages, and the strife of the schools, *vide* Heinrich Ritter, Hist. of the Christian philosophy, p. ii. p. 159, pt. iii. p. 131—160 and 381—417.

[239] (p. 280.)—Cousin, Cours de l'Hist de la Philosophie, vol. i. 1829, p. 360 and 389—436; Fragmens de Philosophie Cartésienne, p. 8—12 and 403. Compare also the new and talented writings of Christian Bartholomess; Jordano Bruno, 1847, vol. i. p. 308; vol. ii. p. 409—416.

[240] (p. 281.)—Jourdain, sur les trad. d'Aristote, p. 236; Michael Sachs, the Religious Poetry of the Jews in Spain, 1845, p. 180—200.

[241] (p. 282.)—The greater merit in establishing a natural history of animals belongs to the Emperor Frederic II. We owe to him important personal observations respecting the internal structure of birds. (*Vide* Schneider in "Reliqua Librorum Friderici II. imperatoris de arte venandi cum avibus, vol. i. 1788, in the preface). Cuvier also calls the Hohenstaufen, the "first working zoologist of the scholastic Middle Ages." Respecting Albert the Great, and his accurate notions of the distribution of heat over the globe in different latitudes, and, according to the difference of the seasons, *vide* his "Liber cosmographicus, de natura locorum," Argent, 1515, fol. 14, *b* and 23, *a* (Examen crit. vol. i. p. 54—58). But in his own observations, Albertus Magnus frequently shows the want of criticism in his age. He believed that he knew "that seed cast upon a good soil changed into wheat; that by putrefaction, a wood of beech trees, when hewn down, becomes a wood of birch trees; that from the branches of an oak-tree stuck in the ground, a vine springs." (Compare also, Ernest Meyer, upon the Botany of the 13th century, in the Linnæa, vol. x. 1836, p. 719.)

[242] (p. 283.)—So many passages in the "Opus majus," prove the esteem which Roger Bacon felt for the works of Grecian antiquity, that, as Jourdain remarked (p. 429), we can only refer the desire expressed in a letter to Pope Clement V. "to burn the books of Aristotle, in order to prevent the spread of error among the schools," to one of the bad Latin translations of the Arabic version.

243 (p. 283.)—Scientia experimentalis a vulgo studentium penitus ignorata; duo tamen sunt modi cognoscendi, scilicet per argumentum et experientiam. (The ideal mode and that of experiment). Sine experientia nihil sufficienter sciri potest. Argumentum concludit, sed non certificat, neque removet dubitationem, ut quiescat animus in intuitu veritatis, nisi eam inveniat via experientiæ, (Opus majus, pt. vi. cap. i.) I have collected all the passages of Roger Bacon referring to physical knowledge and experimental inquiry, in my "Exam Crit. de l'Hist. de la Géogr." vol. ii. p. 295—299. Compare also, Whewell, the Philosophy of the inductive Sciences, vol. ii. p. 323—337.

244 (p. 283.)—*Vide* Kosmos, vol. ii. p. 225. I find the "Optics" of Ptolemæus quoted in the "Opus majus," (ed. Jebb. Lond. 1733), p. 79, 288 and 404. It has been rightly denied that the knowledge obtained from Alhazen, of the magnifying power of segments of spheres, really caused Bacon to construct spectacles, (Wilde, History of Optics, pt. i. p. 92—96); the discovery is said to have been known in 1299, and to belong to the Florentine optician Salvino degli Armati, who was buried in 1317, in the church of St. Maria Maggiore, at Florence. If Roger Bacon, who finished his "Opus majus," in 1267, speaks of instruments for making little letters appear large, "utiles senibus habentibus oculos debiles" his words and the really erroneous considerations which he adds, prove that he could not himself have carried out the ideas of possibility obviously floating before his mind.

245 (p. 284.)—*Vide* my Examen crit. vol. i. p. 61, 64—70, 90—108; vol. ii. p. 349; "Il existe aussi de Pierre d'Ailly, que Don Fernando Colon nomme toujours Pedro de Helieco, cinq mémoires 'de Concordantia astronomiæ cum theologia.' Il rappelle quelques essaies très-modernes de de Géologie hébraïsante publiés 400 ans après le Cardinal."

246 (p. 285.)—Compare the letter of Columbus (Navarrete, Viages y descubr. vol. i. p. 244) with the "Imago Mundi" of the Cardinal d'Ailly, cap. 8, and Roger Bacon's "Opus majus," p. 183.

247 (p. 287.)—Heeren, History of Classical Literature, vol. i. p. 284—290.

248 (p. 287.)—Klaproth, Mémoires relatifs à l'Asie, vol. iii. p. 113.

249 (p. 287.)—The Florentine edition of Homer, 1488: but the first printed Greek book was the grammar of Constantius Lascaris of 1476.

250 (p. 287.)—Villemain, Mélanges historiques et littéraires, vol. ii. p. 135.

[251] (p. 287.)—The result of the investigations of the librarian Ludwig Wachler at Breslau, (*vide* his History of Literature, 1833, Pt. i. p. 12—23). The art of printing without moveable letters does not extend farther back than the beginning of the 10th century even in China. The four first books of Confucius were printed according to Klaproth in the province of Szütschuen between 890 and 925, and the description of the technical manipulation of the Chinese printing might have been read by the inhabitants of the West, as early as 1310, in Raschid-Eddin's Persian history of the governors of Chatai. According to the most recent results of the important inquiries of Stanislas Julien, a blacksmith in China used movable types of baked clay, between the years 1041 and 1048, and therefore almost 400 years before Guttenberg. This was the discovery of Pi-sching, which however was unapplied.

[252] (p. 288.)—*Vide* the proofs in my 'Examen crit.' vol. ii. p. 316—320. Josafat Barbaro (1436) and Ghislin of Busbeck (1555) found between Tana (Asow), Caffa and Erdit (the Wolga), Alani and Gothic races speaking German. (Ramusio, delle Navigationi et Viaggi, vol. ii. p. 92, *b*, and 98, *a*). Roger Bacon calls Rubruquis always only 'Frater Willielmus, quem dominus Rex Franciæ misit ad Tartaros.

[253] (p. 288.)—The great and splendid work of Marco Polo (Il Milione di Messer Marco Polo), as we see in the corrected edition of Count Baldelli, is wrongly called a book of Travels; it is chiefly a descriptive, and we may add, a statistical work, in which it is difficult to distinguish what the traveller himself saw, and what he derived from others, or gathered from the topographical descriptions which are so plentiful in Chinese literature, and which he had an opportunity of attaining through his Persian interpreter. The striking similarity of the report of the travels of Hiuan-tschang, the Buddhist pilgrim of the seventh century, with that of Marco Polo of the Pamir highlands in 1277, early attracted my attention. Jacquet, who was so soon removed from his study of the Asiatic languages, and who, like Klaproth and myself, had for some time employed himself in studying the works of the Venetian travellers, wrote to me shortly before his death: "Je suis frappé comme vous de la forme de rédaction littéraire du Milione. Le fond appartient sans doute à l'observation directe et personnelle du voyageur, mais il a probablement employé des documents qui lui ont été communiqués soit officiellement, soit en particulier. Bien des choses paraissent avoir été empruntées à des livres chinois et mongols, bien que ces influences sur la composition du

Milione soient difficiles à reconnaître dans les traductions successives sur lesquelles Polo aura fondé ses extraits." However much the more recent travellers have been inclined to enter into an account of their own personal adventures, Marco Polo on the other hand endeavours to mix up his own observations with the official accounts communicated to him, which were probably numerous, as he held the post of governor of the town of Yangui, (*vide* my Asie centrale, vol. ii. p. 395). The plan of compiling adopted by the famous traveller renders it intelligible how he was able to dictate his book to his fellow prisoner and friend Messer Rustigielo of Pisa, from the documents before him whilst in prison in Genoa in 1295. (Compare Marsden, Travels of Marco Polo, p. xxxiii.)

254 (p. 288.)—Purchas, Pilgrimes, Pt. iii. chap. 28 and 56, (p. 23 and 34.)

255 (p. 289.) Navarrete, Colleccion de los Viages y Descubrimientos que hiciéron por mar los Españoles, vol. i. p. 261; Washington Irving, History of the Life and Voyages of Christopher Columbus, 1828, vol. iv. p. 297.

256 (p. 289.)—Examen crit. de l'Hist. de la Géogr. vol. i. p. 63 and 215, vol. ii. p. 350; Marsden, Travels of Marco Polo, p. lvii., lxx. and lxxv. During the life of Columbus, the first German translation appeared at Nuremberg in 1477, (*das puch den edeln' Ritters un landtfarers Marco Polo*, the book of the noble knight and traveller, Marco Polo), the first Latin translation in 1490, the first Italian and Portuguese translations in 1502.

257 (291.)—Barros, Dec. i. liv. iii. cap. 4, p. 190, says distinctly; "Bartholomeu Diaz, e os de sua companhia per causa dos perigos, e tormentas, que em o dobrar delle passáram, lhe puzeram nome Tormentoso." The merit of the first circumnavigation therefore does not belong to Vasco de Gama, as is generally supposed. Diaz was at the Cape in May in 1487, and therefore almost at the same time that Pedro de Covilham and Alonzo de Payva of Barcelona commenced their expedition. As early as December 1487, Diaz himself brought to Portugal the account of his important discovery.

258 (p. 291.)—The Planispherium of Sanuto, who calls himself "Marinus Sanuto dictus Torxellus de Veneciis," is a part of the work, 'Secreta fidelium Crucis.' "Marinus prêcha adroitement une croisade dans l'intérêt du commerce, voulant détruire la prospérité de l'Egypte et diriger tous les marchandises de l'Inde par Bagdad, Bassora et Tauris (Tebriz) à Kaffa, Tana (Azow), et aux côtes Asiatiques de la Méditer-

ranée. Contemporain et compatriote de Marco Polo, dont il n'a pas connu le Milione, Sanuto s'élève à de grandes vues de politique commerciale. C'est le Raynal du moyen-âge, moins l'incrédulité d'une abbé philosophe du 18ème siècle." (Examen crit. vol. i. p. 231 and 333—348). The Cape of Good Hope is called the "*Capo di Diab*" upon the map of Fra Mauro, which was made between 1457 and 1459: *vide* the learned writing of Cardinal Zurla: Il Mappamondo di Fra Mauro Camaldolese, 1806, §. 54.

[259] (p. 292.)—*Avron* or *avr* (aur) is a rare word for 'north' instead of the ordinary word *schemâl;* the Arabic *zohron* or *zohr,* from which Klaproth erroneously endeavours to derive the Spanish word *sur* and the Portuguese word *sul* (which, with the word *sud, south,* is doubtless a genuine German word), is not correctly used with reference to a region of a world; it only means the time of mid-day: *Süden* (the south) is called *jnûb.* Respecting the early acquaintance of the Chinese with the southern declination of the magnetic needle, *vide* Klaproth's important investigations in the 'Lettre à M. A. de Humboldt, sur l'invention de la Boussole,' 1834, p. 41, 45, 50, 66, 79 and 90, and the work of Azuni of Nice, 'Dissertation sur l'origine de la Boussole,' p. 35 and 65—68. Navarrete, in his *Discurso historico sobre los progresos del Arte de Navegar en Espana,* 1802, p. 28, records a remarkable passage in the Leyes de las Partidas (ii. tit. ix. ley 28) of the middle of the 13th century. "The needle which guides the mariner in the dark night and shows him in good and bad weather, the direction which he must take, is the mediatrix (*medianera*) between the magnetic stone (*la piedra*) and the north star. . . ." *Vide* the passage in *Las siete Partidas del sabio Rey Don Alonso el IX.* (according to the usual reckoning, *el X.*) Madrid, 1829, vol. i. p. 473.

[260] (p. 292.)—Jordano Bruno par Christian Barthomèss, 1847, vol. ii. 1847, vol. ii. p. 181—187.

[261] (p. 292)—"Tenian los mareantes instrumento, carta, compas y aguja." Salazar, Discurso sobre los progresos de la Hydrografia en España, 1809, p. 7.

[262] (p. 292.)—Kosmos, v. ii. p. 199.

[263] (p. 292.)—Respecting Cusa (Nicolaus of Cuss, properly of Cues on the Moselle), *vide* above, Kosmos, vol. ii. p. 135, and Clemens' treatise upon Giordano Bruno and Nicolaus de Cusa, p. 97, where an important fragment from Cusa's own hand, found three years ago, respecting the triple movement of the earth, is communicated. (Compare

also Chasles, Aperçu sur l'origine des méthodes en Géométrie, 1837, p. 329).

[264] (p. 294.)—Navarrete, Disertacion histórica sobre la parte que tuviéron los Españoles en las guerras de Ultramar ó de las Cruzadas, 1816, p. 100, and Examen crit. vol. i. p. 274—277. An important improvement in observations by means of the plummet is attributed to George von Peuerbach, the teacher of Regiomontanus. The latter instrument was however long before in use among the Arabs, as is proved by the description of the astronomical instruments of Abul-Hassan Ali, edited in the 13th century; Sédillot, 'Traité des instruments astronomiques des Arabes,' 1835, p. 379, 1841, p. 205.

[265] (p. 294.)—In all the accounts of voyages which I have examined, the erroneous notion is kept up that the log was not used to measure the distance traversed before the end of the 16th or the beginning of the 17th century. In the Encyclopædia Britannica, (7th edition, 1842) vol. xiii. p. 416, it says, "the author of the device for measuring the ship's way is not known, and *no mention of it occurs* till the year 1607 in an East Indian Voyage, published by Purchas." This year is also named in all the earlier and later cyclopædias as the earliest date (Gehler, vol. vi. 1831, p. 450). Only Navarrete in the 'Disertacion sobre los progresos del Arte de Navegar, 1802, gives the date of the use of the log-line in an English ship in the year 1577, (Duflot de Mofras, Notice biographique sur Mendoza et Navarrete, 1845, p. 64); afterwards, in another place, (Coleccion de los Viages de los Españoles, vol. iv. 1837, p. 97), he supposes "that at the time of Magellan the speed of the ship was only measured by the eye (*á ojo*) until the 16th century, when the log (*corredera*) was invented. The measurement of "the distance sailed over" by throwing out the log-line, even though the plan in itself was known to be imperfect, was of so much importance in understanding the speed and directions of currents in the sea, that I have been compelled to devote special attention to this fact. I here communicate the principal results, which are contained in the 6th volume (as yet unpublished), of my Examen critique de l'Histoire de la Géographie, et des progrès de l'Astronomie nautique. The Romans, in the time of the Republic, had upon their ships an apparatus for measuring the way, which consisted of wheels about four feet high, provided with paddles, at the very edge of the ship, just as in our steam-boats, and like the plan of moving vessels, which Blasco de Garay, 1543, offered to the Emperor

Charles V. in Barcelona (Arago, Annuaire du Bur. des Long. 1829, p. 152). The ancient Roman metre (ratio a majoribus tradita, qua in via rheda sedentes vel mari navigantes scire possumus quot millia numero itineris fecerimus) was circumstantially described by Vitruvius, (lib. x. cap. 14), the date of whose life, supposed to have been in the Augustan Age, has recently been doubted by C. Schulz and Osann. By means of three toothed wheels working one within the other, and the falling of small round pebbles out of a chamber (*loculamentum*) which had only one hole, the number of revolutions of the outermost wheels, which dipped into the sea, and the number of miles passed over in a day's journey, were determined. Whether the *Hodometer* was much used in the Mediterranean, "for it may be useful and afford pleasure," Vitruvius does not say. In the description of the life of the Emperor Pertinax, by Julius Capitolinus, mention is made of the sale of the property of the Emperor Commodus, (cap. 8, in Hist. Augustæ Script. ed. Lugd. Bat. 1671, vol. i. p. 554), in which there was a travelling carriage, furnished with a similar apparatus for measuring the distance. The wheels indicated at the same time "the measure of the distance and the duration of the journey" in hours. Hero of Alexandria, the pupil of Ctesibius in his Grecian (still unpublished) work upon Dioptrics, (*vide*, Venturi, Comment. la Storia dell' Ottica, Bologna, 1814, vol, i. p. 134—139), describes a much more perfect instrument, also applicable to sea and land. In the literature of the entire Middle Ages, nothing is found upon this subject until we come to the age of several handbooks of navigation, which were composed, or at any rate printed, very soon after one another: they were, a work (*Trattato di Navigazione*, probably before 1530) by Antonio Pigafetta, by Francisco Falero (1535, brother of the astronomer Ruy Falero, who is said to have accompanied Magellan on his voyage round the world, and wrote a work "Regimiento para observar la longitud en la mar)," by Pedro de Medica of Seville (*Arte de navegar*, 1545,) by Martin Cortes of Bujalaroz (*Breve Compendio de la esfera y de la arte de navegar*, 1551), and by Andres Garcia de Cespedes (*Regimiento de Navegacion y Hidrogafia*, 1606). From all these works, which are very rare at the present day, as well as from the *Suma de Geografia*, which Martin Fernandez de Enciso edited in 1519, we see most clearly that the "distance sailed over" by Spanish and Portuguese ships was not determined by any immediate measurement, but by estimating with the eye and according to certain established rules. Medina says (lib. iii.

cap. 11 and 12) "in order to know the course of the ship and the distance passed over, the pilot must mark down in his register by hours, (that is by the hour-glass, *ampolleta*), the space traversed by the vessel: he must therefore know that the most which he will advance in one hour is four miles, with less wind three, and sometimes only two . . . . Caspedes (Regimiento, p. 99 and 156), calls this proceeding, as does also Medina, "*echar punto por fantasia.*" The *fantasia*, as Enciso earnestly remarks, depends upon the knowledge which the pilot has respecting the quality of his vessel, which must be taken into consideration, if he would avoid great error; but, altogether, one who is long at sea must have remarked with wonder, how completely the mere estimation of the speed of the ship, when the waves are not very high, coincides with the subsequent results, as shewn by casting the log. Some Spanish pilots call the ancient and dangerous method of estimating the distance (cuenta de estima), with very unjust sarcasm, *la corredera de los Hollandeses corredera de los perezosos.* In the ship's journal of Christopher Columbus, mention is frequently made of a dispute with Alonso Pinzon, respecting the distance which they had passed over since their departure from Palos. The hour-glasses which they used (*ampolletas*) ran down in half an hour, so that the space of a day and night is reckoned at forty-eight. In that important journal of Columbus (for example, on the 22nd of January, 1493; *andaba* 8 *millas por hora hasta pasadas* 5 *ampolletas, y* 3 *antes que comenzase la guardia, que eran* 8 *ampolletas* (Navarrete, vol. i. p. 143), the log, *la corredera*, was never mentioned. Can we suppose that Columbus may have known and made use of it, and have not thought it worthy of mention, as being such an usual instrument, as Marco Polo did not mention the tea or the Chinese wall? Such a supposition appears to me to be very improbable, because, in the proposals which the pilot Don Jayme Ferrer made in 1495, accurately to explore the position of the Pope's line of demarcation, he puts it down to the determination of the distance sailed over, and yet only the unanimous opinion (*juicio*) of 20 experienced sailors is considered, (que apunten en su carta de 6 en 6 horas el camino que la nao fará segun su juicio). If the log had been used, Ferrer would certainly have laid down how frequently it should have been used. I find the first use of the log mentioned in a passage of Pigafetta's Journal of Magellan's Voyage round the World, which had long been buried among the manuscripts in the Ambrosian library, at Milan. It says there, in January 1521 when Magellan had

already arrived in the South Sea, "*Secondo la misura che facevamo del viaggio colla catena a poppa, noi percorrevamo da 60 in 70 leghe al giorno*". (Amoretti, Primo Viaggio intorno al Globo terracqueo, ossia Navigazione fatta dal Cavaliere Antonio Pigafetta sulla squadra del Cap. Magaglianes, 1800, p. 46.) What can this apparatus of a "chain at the stern of the vessel, (*catena a poppa,*) of which we made use throughout all the voyage to measure the distance," have been, except some contrivance, like our log? The log-line divided out into knots, the log-board and the half-minute, or log-glass, are not specially mentioned; but this silence is nothing to wonder at, when he speaks of something he had already known. Also in a part of the *Trattato di Navigazione* of the Cavalier Pigafetta, edited by Amoretti (only of ten pages, it is true), the *catena della poppa* is not mentioned.

266 (p. 295.)—Barros, Dec. i. lib. iv. p. 320.

267 (p. 296.)—Examen crit. vol. i. p. 3—6 and 290.

268 (p. 297.)—Compare Opus Epistolarum Petri Martyris Anglerii Mediolanensis, 1670, ep. cxxx. and clii. "Præ lætitia prosiliisse te, vixque à lachrymis præ gaudio temperasse, quando literas adspexisti meas quibus de Antipodum Orbe, latenti hactenus, te certiorem feci, mi suavissime Pomponi, insinuasti. Ex tuis ipse literis colligo, quid senseris. Sensisti autem, tantique rem fecisti, quanti virum summa doctrina insignitum decuit, quis namque cibus sublimibus præstari potest ingeniis isto suavior? quod condimentum gratius? à me facio conjecturam. Beari sentio spiritus meos, quando accitos alloquor prudentes aliquos ex his qui ab ea redeunt provincia (Hispaniola insula)." The expression *Christophorus quidam Colonus,* reminds me of the quotation, (I do not say, too often or unjustly made), "*nescio quis Plutarchus,*" of Aulus Gellius (Noct. Atticæ xi. 16), and of the "*quodam Cornelio scribente,*" in the answer of the King Theodoric, which he wrote to the princes of the Æstyans, and which was to instruct them respecting the true origin of amber, from the 45th chapter of the German of Tacitus.

269 (p. 297.)—Opus Epistol. No. ccccxxxvii. and dlxii. Also the talented Hieronymus Cardanus, an imaginative, and at the same time, acute mathematician, in his "*Physical Problems,*" draws attention to the spread of geographical knowledge from facts, the observation of which was begun by one man! Cardani Opera, ed. Lugdun. 1663, vol. ii. probl, p. 630 and 659; at nunc quibus te laudibus afferam, Christophore Columbi, non familiæ tantum non Genuensis urbis, non Italiæ Provinciæ,

non Europæ partis orbis solum sed humani generis decus. In comparing the problems of Cardanus with those of the later school of Aristotle, in the confusion and weakness of physical descriptions equally prevalent in both collections, it is evidently characteristic of the age when geography was so suddenly extended, that Cardanus assigns the greater part of his problems to the study of comparative meteorology. I remember especially, his considerations upon the warmth of the climate in the island of England, in contrast to the winter in Milan; on the dependence of hail upon electric explosions; on the cause and direction of currents in the ocean; on the maximum of the atmospheric heat and coldness which comes after each solstice; on the height of the snow regions in the Tropics; on the temperature which is caused by radiation of heat from the sun and stars; on the greater amount of light in the southern sky, &c. "Cold is merely absence of heat. Light and heat are only different in name, and are, in themselves, inseparable." Cardani Opera, vol. i. de vita propria p. 40; vol. ii. probl. p. 621, 630—632, 653 and 713; vol. iii. de subtilitate, p. 417.

[270] (p. 299.)—*Vide* my Examen crit. vol. i. p. 210—249. According to the manuscript *Historia general de las Indias*, lib. i. cap. 12, "*la carta de marear, que Maestro Paulo Fisico* (Toscanelli), *envió á Colon*," was in the hands of Bartholemé de las Casas, when he wrote his work. Columbus' Journal, of which we possess an edition (Navarrete, vol. i. p. 13,) does not altogether agree with the narrative which I find in the manuscript of Las Casas, for whose kind communication I have to thank M. Ternaux-Compans. The ship's journal says, "Iba hablando el Almirante (Martes 25 de Setiembre 1492), con Martin Alonso Pinzon, capitan de la otra carabela Pinta, sobre una carta que le habia enviado tres dias hacia á la carabela, donde segun parece tenia pintadas el Almirante ciertas islas por aquella mar." . . . . On the other hand, in the manuscript of Las Casas, lib. i. cap. 12, it is thus: "La carta de marear que embió (Toscanelli al Amirante) yo que esta historia escrivo la tengo en mi poder. Creo que todo su viage sobre esta carta fundó," lib. i. cap. 38: "asi fué que el martes 25 de Setiembre llegase Martin Alonso Pinzon con su caravela Pinta a hablar con Christobal Colon sobre una carta de marear que Christobal Colon le avia embiado. . . . . Esta carta es la que le embió Paulo Fisico el Florentin, la qual yo tengo en mi poder con otras cosas del Almirante y escrituras de su misma mano que traxéron à mi poder. En ella le pintó muchas islas . . . . " Shall we suppose that

the admiral marked down in the map of Toscanelli, the islands he expected to find, or are we to consider that *tenia pintadas* means merely "The admiral had a map, on which was marked . . . . ."

[271] (p. 299.)—Navarrete, Documentos No. 69, in vol. iii. of the Viages y Descubr. p. 565—571; Examen Crit. vol. i. p. 234—249 and 252; vol. iii. p. 158—165 and 224. Respecting the contested point of the first landing-place in the West Indies, *vide* vol. iii. p. 186—222. The map of the world of Juan de la Cosa, with which I am acquainted, and which became so famous, being published in the year 1832, during the epidemic of the Cholera, by Walckenär, was sketched six years before the death of Columbus, and has thrown new light upon this discussed question.

[272] (p. 300.)—Upon Columbus' talent for the description of Nature's beauties, which he did frequently in a poetical way, *vide* above, Kosmos, vol. ii. p. 53—55.

[273] (p. 302.)—*Vide* the results of my investigations in the "Relation historique du Voyage aux Régions équinoxiales du Nouveau Continent," vol. ii. p. 702; and Examen Crit. de l'hist. de la Géographie, vol. i. p. 309.

[274] (p. 302.)—Biddle, Memoir of Sebastian Cabot, 1831, p. 52—61; Examen Crit. vol. iv. p. 231.

[275] (p. 302.)—In an almost unnoticed passage in Columbus's Journal of Nov. 1, 1492, he says, "I am (in Cuba), opposite and near to *Zayto y Gainsay* (Zaitun et Quinsay, Marco Polo ii. 77), *del Gran Can.*" (Navarrete, Viages y descubrim. de los Españoles, vol. i. p. 46, and above, p. 457, note 235.) The curve to the south, which Columbus noticed on the western part of the land of Cuba upon his second voyage, had an important influence on the discovery of South America, upon the Delta of the Orinoco, and the promontory of Para, as I have shewn in another place; *vide* Examen Crit. vol. iv. p. 246, 250. "Putat (Colonus)," says Anghiera, (Epist. clxviii. ed. Amst. 1670, p. 96), "regiones has (Pariae) esse Cubæ contiguas et adhærentes: ita quod utræque sint Indiæ Gangetidis continens ipsum. . . . ."

[276] (p. 302.)—*Vide* the important manuscript of Andreas Bernaldez, *Cura de la Villa de los Palacios* (History of the Catholic Kings, cap. 123). This history includes from 1488 to 1513. Bernaldez received Columbus into his house on his return from his second voyage, in the year 1496. By the great kindness of M. Ternaux-Compans, to whom we owe many

valuable explanations in the history of the *Conquista.* I had it in my power to make a free use of this manuscript, which was in the possession of my distinguished friend, the historian, Don Juan Bautista Muñoz, in Paris, in December, 1838. (Compare Fern. Colon, *Vida del Almirante*, cap. 56.)

[277] (p. 302.)—Examen crit. vol. iii. p. 244—248.

[278] (p. 303.)—Cape Horn was discovered in February, 1526, by Francisco de Hoces, upon the expedition of the Comendador Garcia de Loaysa, which was intended to go to the Moluccas, in the course in which Magellan sailed. Whilst Loaysa sailed through the Straits of Magellan Hoces, with his Caravel, San Lesmes, separated himself from the rest of the vessels, and was driven fifty-five degrees further southward. *Dijéron los del buque que les parecia 'que era alli acabamiento de tierra;"* Navarrete, Viages de los Españoles, vol. v. p. 28 and 404—488. Fleurieu supposes that Hoces had only seen the *Cabo del buen Successo*, to the west of the State Islands. Towards the end of the 16th century, so remarkable an uncertainty prevailed respecting the form of the land, that the Singers of Araucana believed (Canto i. Oct. 9), that the Straits of Magellan had been closed by an earthquake, which lifted up the bottom of the sea; on the other hand, Acosta (*Historia natural y moral de las Indias*, lib. iii. cap. 10), maintained that Terra del Fuego was the beginning of a vast polar region, extending southwards. (Compare also Kosmos, vol. ii. p. 60 and 120.)

[279] (p. 304.)—I have elsewhere circumstantially inquired into the question, whether the hypothesis of the isthmus, according to which the eastern African promontory of Prasum is attached to the eastern Asiatic projection of the land at Thinæ, may be traced back to Marinus Tyrius, to Hipparchus, or to Seleucus of Babylon, or whether it did not rather originate with Aristotle (de Cœlo ii. 14; *vide* Examen crit. vol. i. p. 144, 161 and 329; vol. ii. p. 370—372.)

[280] (p. 305.)—Paolo Toscanelli was so distinguished as an astronomer, that Regiomontanus, the teacher of Martin of Bohemia, in 1463 dedicated his work, *de Quadratura Circuli*, directed against the Cardinal Nicholas de Cusa, to him. He constructed the great dial in the church Santa Maria Novella, at Florence, and died in 1482, at an age of 85 years, without having had the pleasure of surviving to hear of the discovery of the Cape of Good Hope by Diaz, and of the tropical part of the New Continent by Columbus.

[281] (p. 306.)—As the Old Continent measures about 130°, from the

western extremity of the peninsula of Spain to the coast of China, about 230° remain for the space over which Columbus would have had to sail if he would come to Cathai (China), but fewer if he only wished to reach as far as Japan (Zipangi). The difference of 230°, which I have mentioned, is taken from the position of the Portuguese promontory St. Vincent, (longitude 11° 20′ west of Paris), and the projecting Chinese shore of Quinsay (lat. 30° 28′, long. 117° 47′ east of Paris), which was formerly so famous, and which was so frequently mentioned by Columbus and Toscanelli. *Kanfu, Hangtscheufu, Kingszu,* are synonyms for Quinsay, in the province of Tschekiang. The trade in the east of Asia, was, in the 13th century, divided between Quinsay and Zaitun (Pinjhai or Tseuthung), which is opposite the island Formosa (formerly Tungfan), at 25° 5′ of north latitude (*vide* Klaproth, Tableaux hist. de l'Asie, p. 227.) The distance of the Cape St. Vincent from Zipangi, (Niphon), is 22 degrees of longitude less than from Quinsay, and, therefore, instead of 230° 53′ is only about 209°. It is striking, that the oldest opinions, namely, those of Eratosthenes and Strabo, (lib. i. p. 64), come, by accidental calculation, within ten degrees of the above-named result of 129°, for the meridian distance of the ends of the *οἰκουμένη*. Strabo says, almost in the same passage where he supposes the possible existence of two habitable continents in the northern hemisphere, that our *οἰκουμένη*, in the parallel of Thinæ (Athens, *vide* above Kosmos vol. ii. p. 220), makes up more than a third of the whole circumference of the earth. Marinus Tyrius, who was led into a mistake from the length of the voyage from Myos Hormus to India, from the erroneous notions prevalent with regard to the direction of the great axis of the Caspian, from west to east, and from over-estimating the length of the journey by land to the Seres, allowed 225° instead of 129°, as the width of the Old Continent. The Chinese coast was, in this way, brought to the position of the Sandwich Islands. Columbus naturally prefers this result to that of Ptolemæus, according to which, Quinsay would fall only in the eastern part of the Archipelago of the Carolinas. Thus Ptolemæus, in the Almagest (ii. 1.) places the coast of *Sinæ* in 180° in his geography (lib. i. cap. 12), in 177¼°. As Columbus considered the voyage from Iberia to Sinæ to be 120°, and Toscanelli estimated it at 52°, they might certainly both call their bold undertaking, a search for the *brevissimo camino*, when they considered the length of the Mediterranean to be about 40°. Also Martin of Bohemia placed in the famous

terrestrial globe, which he completed in 1492, and which is still kept in his house at Nuremberg, the coast of China (the throne of the King of Mango, Cambalu and Cathay), only 100° west of the Azores; that is, as Martin lived four years in Fayal, and probably reckons his distance therefrom, he considered it only 119° 40′ west of the Cape of St. Vincent. Columbus was probably acquainted with Martin, in Lisbon, where they both lived from 1480 to 1484 (*vide* Examen crit. de l'hist. de la Géographie, vol. ii. p. 357—369.) The numerous erroneous numbers which we find in all the writings respecting the discovery of America, and the supposed extension of the eastern Asiatic coast, induced me to compare more accurately the opinions of writers of the Middle Ages with those of classical antiquity.

[282] (p. 306.)—The eastern part of the Pacific Ocean was first navigated by white men in a canoe, when Alonzo Martin de Don Benito, (who, together with Vasco Nuñez de Balboa, on the 25th of September, 1513, had seen the distant sea in the horizon from the little mountain chain of Quarequa,) some days afterwards went down to the isthmus, to the *Golfo de San Miguel*, before Balboa carried into effect his adventurous ceremony of taking possession. Seven months before this time, in January 1513, Balboa informed his Court that the southern sea, of which he had heard the natives speak, was easily navigated; "*Mar muy mansa y que nunca anda brava como la mar de nuestra banda*" (*de las Antillas*). The name *Oceano Pacifico*, was, however, as Pigafetta relates, first given to the *Mar del Sur* (of Balboa), by Magellan. Before the commencement of Magellan's expedition (10th August 1519), the Spanish government, who had no want of careful activity, sent in Nov. 1514, secret orders to Pedrarius Davila, Governor of the Province Castilla del Oro (in the north-west part of South America), and, at the same time, to the great mariner, Juan Diaz de Solis; to the former, to have four caravels built in the *Golfo de San Miguel*, "in order to make discoveries in the newly discovered South Sea;" to the latter, to find an opening (*abertura de la tierra*,) from the eastern coast of America, in order to get to the back (à espaldas) of the new land, that is, to the western part of Castilla del Oro, where the sea bounds it. The expedition of Solis (from October 1515, to August 1516), went far to the south, to the discovery of the Rio de la Plata, which was, for a long time, called Rio de Solis. (Compare upon this first discovery of the Pacific, which is but little known, Petrus Martyr, epist. dxl. p. 296, with the documents of 1513—1515, in

Navarrete, vol. iii. p. 134 and 357; and also my Examen crit. vol. i. p. 320 and 350.)

[283] (p. 306.)—*Vide* respecting the geographical position of the two unfortunate islands, *Desventuras*, (San Pablo, lat. 16¼° south, long. 135¾° west of Paris; Isla de Tiburones, lat. 10¾° south, long. 145°). Examen crit. vol. i. p. 286, and Navarrete, vol. iv. p. lix. 52, 218 and 267. The grand epoch of the vast discoveries in space, gave manifold cause to the famous inscription on the coat-of-arms which we have mentioned in the text as belonging to the successors of Sebastian de Elcano (*Primus circumdedisti me.*) The arms given to Columbus, on the 20th of May, 1493, "to make his person renowned to posterity, *para sublimarlo,*" contains the first map of America, a row of islands, in front of which is a gulf. (Oviedo, hist. general de las Indias, ed. de 1547, lib. ii. cap. vii. fol. 10, *a.*; Navarrete, vol. ii. p. 37; Examen crit. vol. iv. p. 236). The Emperor Charles V. gave to Diego de Ordaz, who boasted that he had ascended the Volcano Orizaba, the picture of the summit of this mountain, and to the historian Oviedo, who lived 34 years (from 1513—1547), continuously in tropical America, the four beautiful stars of the southern cross, as a crest. (Oviedo, lib. ii. cap, xi. fol. 16 *b.*)

[284] (p. 307.)—*Vide* my "Essai politique sur le Royaume de la Nouvelle Espagne, vol. ii. (1827), p. 259, and Prescott, History of the Conquest of Mexico, (New York, 1843), vol. iii. p. 271 and 336.

[285] (p. 309.)—Gaetano discovered one of the Sandwich Islands in 1542. Respecting the voyage of Don Jorge de Menezes (1526), and of Alvaro de Saavedra (1528), to the *Ilhas de Papuas*, *vide* Barros da Asia, Dec. iv. lib. i. cap. xvi. and Navarrete, vol. v. p. 125. The *Hydrographie* of Joh. Ross (1542), which is preserved in the British Museum, and was examined by the learned author, Dalrymple, contains sketches of New Holland, and a collection of maps by Jean Balard of Dieppe (1552), our first acquaintance with which we owe to M. Coquebert Monbret.

[286] (p. 309.).—After the death of Medaña, his wife, Doña Isabella Baretos, who was remarkable for personal courage and great intellectual gifts, took the command of the expedition, which did not end until 1596 (Essai pol. sur la Neuv. Esp. vol. iv. p. 111.) Quiros introduced in his ships the plan of making salt water fresh, and his example was followed in numerous instances. (Navarrete, vol. i. p. liii.) The entire operation, as I have elsewhere pointed out, upon the testimony of

Alexander of Aphrodisias, was known in the third century after our era, although it was not used in ships.

[287] (p. 310.)—*Vide* the splendid work of Professor Meinicke, in Prenzlau; "The Continent of Australia, a geographical Monograph," 1837, pt. i. p. 2—10.

[288] (p. 312.)—This king died at the time of the Mexican king Axayacatl, who reigned from 1464 to 1477. One of the descendents of Nezahualcoyotl, a poet king, was the learned historian Fernando de Alva Ixtlilxochitl, whose manuscript Chronicles of the Chichimeques I saw in 1803, in the palace of the Viceroy of Mexico, and of which Prescott has made such a happy use. (Conquest of Mexico, vol. i. p. 61, 173 and 206, vol. iii. p. 112). The Aztekish name of the historian Fernando de Alva, means "Vanilla-faced." M. Ternaux-Compans printed a French translation of this manuscript in Paris, in 1840. The account of the long elephants hair, which Cadamosto collected, is found in Ramusio, vol. i. p. 109, and in Grynæus, cap. xliii. p. 33.

[289] (p. 313.)—Clavigero, "Storia antica del Messico," (Cesena, 1780), vol. ii. p. 153. After the unanimous testimony of Hernan Cortes, in his reports to the Emperor Charles V. of Bernal Diaz, Gomora, Oviedo and Hernandez, there can be no doubt that at the time the conquest of Montezuma's kingdom, there were menageries and botanical gardens (collections of living animals and plants) in no part of Europe, which could at all compare with those in Huaxtepec, Chapoltepec, Iztapalapan, and Tezcuco. (Prescott, vol. i. p. 178; vol. ii. p. 66 and 117—121; vol. iii. p. 42.) Respecting the earliest notice of fossil bones mentioned in the text, as found in the American "Giants' Plains," *vide* Garcilaso, lib. ix. cap. ix., Acosta, lib. iv. cap. xxx. and Hernandez (1556), vol. i. cap. xxxii. p. 105.

[290] (p. 315.)—Observations de Christophe Colomb. sur le passage de la Polaire par le méridien, in my "Relation hist." vol. i. p. 506, and in the Examen crit. vol. iii. p. 17—20, 44—51 and 56—61. (Compare also, Navarrete, in the Journal of Columbus, of 16—30, Sept. 1492, p. 9, 15, and 254.)

[291] (p. 316.)—Respecting the remarkable differences of the *Bula de concesion á los Reyes Catholicos de las Indias descubiertas y que se descubrieren* (of May 3rd, 1493), and the *Bula de Alexandro VI. sobre la particion del Oceano* (of Sept. 25, 1493), *vide* Examen crit. vol iii. p. 52—54. The line laid down on June 7, 1494, is very different from this

line of demarcation in the *Capitulacion de la particion del Mar Oceano entre los Reyes Catholicos y Don Juan Rey de Portugal*, 370 *leguas*, (17½ in one Equatorial degree) to the west of the Cape Verd Islands; (compare Navarrete, Coleccion de los Viages y descubr. de los Esp. vol. ii. p. 28—35, 116—143 and 404, vol. iv. p. 55 and 252.) The latter line, which led to the purchase of the Molluccas, (*de el Maluco*) for Portugal in 1529, for the sum of 350,000 gold ducats, had no relation to magnetic or meteorological fancies. The Pope's line of demarcation, however, deserves to be more closely considered in this place, because, as is mentioned in the text, it exercised a great influence upon their endeavours to perfect themselves in nautical astronomy and the methods of determining the longitude. It is also very wonderful, that the *Capitulacion* of June 7, 1494, was the first example of a strict determination of a meridian by marks engraved on a rock, or by the erection of towers. It is ordered, "que se haga alguna señal ó torre," wherever the meridian boundary, from Pole to Pole, in the eastern or western hemisphere, cuts through an island or a continent. In the continents, the *raya* was marked at different distances by a row of these signs or towers; and this was certainly no small undertaking.

[292] (p. 317.)—It appears to me to be very well worth remarking, that the earliest classical writer upon terrestrial magnetism, William Gilbert, who could not be suspected of the least knowledge of Chinese literature, considered the mariner's compass as a Chinese discovery, which Marco Polo had brought to Europe. "Illa quidem pixide nihil unquam humanis excogitatum artibus humano generi profuisse magis, constat· Scientia nauticæ pyxidulæ traducta videtur in Italiam per Paulum Venetum, qui circa annum MCCLX. apud Chinas artem pyxidis didicit." (Guilielmi Gilberti Colcestrensis, Medici Londinensis, de Magnete Physiologia nova, Lond. 1600, p. 4.) There is nothing to establish the fact that Marco Polo, whose voyages took place in the years 1271—1295, brought back the knowledge of the magnet; he returned to Italy at the time when Guyot de Provence, in his poem of the "Mariner's Compass," as well as Jacques de Vitry and Dante, mentioned it as an instrument with which they had been long acquainted. Before Marco Polo started upon his voyage, in the middle of the 13th century, the Catalonians and Basques made use of the compass. (*Vide* Raymundus Lullus, in his treatise *De Contemplatione*, written in 1272.)

[293] (p. 319.) The testimony respecting the death of Sebastian Cabot

is seen in the work of Biddle (Memoir of Seb. Cabot, p. 222), a book which is edited with considerable historical and critical power, "We know," says Biddle, "neither the year of the great mariner's death, nor his burying place, with accuracy; he gave almost an entire continent to Great Britain, and without him (as also without Sir Walter Raleigh), the English language would not have been spoken by many millions of the inhabitants of America." Respecting the materials from which the variation-map of Alonso de Sta. Cruz was compiled, as also respecting the variation-compass, the arrangement of which permitted them to take the sun's altitude at the same time, *vide* Navarrete, *Noticia Biographica del Cosmografo Alonso de Santa Cruz*, p. 3—8. The first variation-compass was constructed by an ingenious apothecary of Seville, Felipe Guillen. The attempts to learn more accurately the direction of the magnetic curves of the dip of the needle was so great, that Juan Jayme sailed in 1585, with Francisco Gali, from Manila to Acapulco, for that purpose alone, in order to test, in the South Sea, an instrument which he had discovered for determining the dip. *Vide* my *Essai polit. sur la Nouv. Esp.* vol. iv. p. 110.

[294] (p. 319.)—Acosta, Hist. Natural de las Indias, lib. i. cap. xvii. These four magnetic lines without variation led Halley to the theory of four magnetic poles, in consequence of the disputes between Henry Bond and Beckborrow.

[295] (p. 319.)—Gilbert, de Magnete Physiologia nova, lib. v. cap. viii. p. 200.

[296] (p. 320.)—In the temperate and frigid zones, this curve of the Isothermic lines, between the western coast of Europe and the eastern coast of North America is general, but within the tropics, they run almost parallel to the Equator; and, in the hasty conclusions to which Columbus was led, he did not notice the difference between the climate at sea and on shore, nor on the eastern and western coasts, nor the influence of the latitude, and the winds which blew over Africa. (Compare the remarkable observations respecting the climate, which are collected in the *Vida del Almirante*, cap. lxvi.) The early suspicion which Columbus entertained respecting the curves of the Isothermic lines in the Atlantic was well-grounded, if we limit it to the zones external to the Tropics (the temperate and frigid zones).

[297] (p. 320.)—An observation of Columbus. (*Vida del Almirante*, cap. lv; Examen crit. vol. iv. p. 253; Kosmos, vol. i. p. 470.)

[298] (p. 320.)—The admiral, says Fernando Colon, (Vida del Alm. cap. lviii.), attributed to the extent and the thickness of the woods covering the brows of the hills, the numerous refreshing showers of rain which cooled the atmosphere whilst he was sailing along the coast of Jamaica. He remarked on this occasion in his ship's journal, that, "formerly the quantity of water was equally as great in Madeira, in the Canary Islands, and Azores, but that since the time when they cut down the overshadowing trees, the rain had been less frequent there." This warning has remained almost unnoticed for three centuries and a half.

[299] (p. 321)—Kosmos, vol. i. p. 361 and 473, Examen crit. vol. iv. p. 294. Asie Centrale, vol. iii. p. 235. The inscription of Adulis, almost fifteen hundred years before Anghiera, speaks of "Abyssinian snow, into which they sink up to the knees."

[300] (p. 322.)—Leonardo da Vinci, well says of this experience; *questo è il methodo da osservarsi nella ricerca de' fenomeni della natura*; *vide* Venturi, Essai sur les ouvrages physico-mathématiques de Léonard da Vinci, 1797, p. 31; Amoretti, "Memorie storiche sù la vita di Lionardo da Vinci," Milano, 1804, p. 143, (in his edition of the *Trattato della Pittura*, vol. xxxiii. of the "Italian Classics.") Whewell, Philos. of the Inductive Sciences, 1840, vol. ii. p. 368—370; Brewster, Life of Newton, p. 332. The principal physical works of Leonardo da Vinci, are of the year 1498.

[301] (p. 323.)—The reports of the ancient Spaniards prove what great attention the mariners of the early ages paid to natural phenomena. Diego de Lepe, for example, found in 1499 (as we learn from testimony in the fiscal process against the heirs of Christopher Columbus) by means of a vessel provided with valves, which opened when it was sunk in the sea, that from the mouth of the river Orinoco, a layer of fresh water, six fathoms deep, covered over the salt water. (Navarrete, Viages y descubrim, vol. iii. p. 549.) Columbus drew some milk-white water from the sea ("White as if flour had been mixed with it") to the south of the island of Cuba, in order to take it with him to Spain in bottles, (Vida del Almirante, p. 56.) For the purpose of determining the longitude, I was at the same place, and I wondered that the opaque white colour of the sea-water, which is so usual in shallow places, could have appeared to be an unexpected phenomenon to the experienced old admiral. With respect to the Gulf-stream itself, which is to be considered as an important phenomenon of Nature, its effects had been frequently noticed at the

Azores and Canary Islands, long before the discovery of America, by the floating of bamboos, stems of pines, and wonderfully formed bodies from the Antilles, and even by the involuntary landing of strange men in canoes, "which never can sink." This was, at that time, ascribed to the violence of storms. (Vida del Almirante, cap. viii.; Herrera, Dec. i. lib. i. cap. ii.; lib. ix. cap. xii); they did not recognize the movement of the waters independently of the winds, nor the simultaneous and reciprocal course of the stream towards the east and south-east; that is, the impulse which brought every year the tropical fruits of the Antilles to the Irish and Norwegian shores. Compare the Memoirs of Sir Humphrey Gilbert, "Upon the possibility of a north-west passage to China," in Hakluyt, Navigations and Voyages, vol. iii. p. 14: Herrera, Dec. i. lib. ix. cap. xii., and Examen crit. vol. ii. p. 247—257; vol. iii. p. 99—108.

302 (p. 324.)—Examen crit. vol. iii. p. 26 and 66—69: Kosmos, vol. i. p. 333 and 335.

303 (p. 325.)—Alonso de Ercilla has imitated the passage of Garcilaso in the Araucana, "Climas, passè, mudè constelaciones;" *vide* Kosmos, vol. ii. p. 112, note 62.

304 (p. 326.)—Petr. Mart. Ocean. Dec. i. lib. ix. p. 96; Examen crit. vol. iv. p. 221 and 317.

305 (p. 326.)—Acosta, Hist. natural de las Indias, lib. i. cap. 2 Rigaud, Account of Harriot's Astronom. Papers, 1833, p. 37.

306 (p. 327.)—Pigafetta, *Primo Viaggio intorno al Globo terracqueo*, pubbl. da C. Amoretti, 1800, p. 46; Ramusio, vol. i. p. 355, *c;* Petr. Martyr. Ocean. Dec. iii. lib. i. p. 217. (According to the events which Aughiera, Dec. ii. lib. x. p. 204 and Dec. iii. lib. x. p. 232, brings forward, the passage of the *Oceanica* of Anghiera which treats of the Magellanic clouds must have been written between 1514 and 1516). Andrea Corsali, also (Ramusio, vol. i. p. 177) describes in a letter to Giuliano de' Medici the circular translatoric movement of the *due nugolette de ragionevol grandezza*. The star, which he represents between the Nubecula major and minor, appears to me to be β Hydræ; Examen crit. vol. v. p. 234—238. Respecting Petrus Theodori von Emden and Houtmann, the pupils of the mathematician Plancius, *vide* an historical paper by Olber in Schumacher's Annual for 1840, p. 249.

307 (p. 328.)—Compare the investigations of Delambre and Encke with Ideler's 'Origin of the names of the Stars,' p. xlix. 263 and 277;

also my Examen crit. vol. iv. p. 319—324, vol. v. p. 17—19, 30 and 230—234.

[308] (p. 329.)—Plin. ii. 70; Ideler, Names of the Stars, p. 260 and 295.

[309] (p. 330.)—I have elsewhere attempted to solve the doubts expressed by numerous distinguished commentators upon Dante in modern times, respecting the *quattro stelle.* In order to comprehend the problem in its entire extent, the passage: "Io mi volsi . . . ." (Purgat. i. v. 22—24) must be compared with other passages, for example, with Purg. i. v. 37; viii. v. 85—93; xxix. v. 121; xxx. v. 97; xxxi. v. 106; and Inf. xxvi. v. 117 and 127. De Cæsaris, the Milanese astronomer, considers the three *facelle (Di che'l polo di quà di tutto quanto arde,* and which set when the four stars of the Cross rise,) to be Canopus, Achernar and Fomahaut. I have endeavoured to solve the difficulties by the following remarks; "Le mysticisme philosophique et religieux qui pénètre et vivifie l'immense composition du Dante, assigne à tous les objets, à côté de leur existence réelle ou matérielle, une existence idéale. C'est comme deux mondes, dont l'un est le reflet de l'autre. Le groupe des quatre étoiles représente, dans l'ordre moral, les *vertus cardinales,* la prudence, la justice, la force et la tempérance; elles méritent pour cela le nom de 'saintes lumières, *luci sante.*' Les trois étoiles 'qui éclairent le pole,' représentent les *vertus théologales,* la foi, l'espérance et la charité. Les premiers de ces êtres de nous révèlent eux-mêmes leur double nature; ils chantent: 'Ici nous sommes des nymphes, dans le ciel nous sommes des étoiles; *Noi sem qui Ninfe, e nel ciel semo stelle.*' Dans la *Terre de la vérité,* le Paradis terrestre, sept nymphes se trouvent réunies: *In cerchio le facevan di se claustro le sette Ninfe.* C'est la réunion des vertus cardinales et théologales. Sous ces formes mystiques, les objets réels du firmament, éloignés les uns des autres, d'après les lois éternelles de la *Mécanique céleste,* se reconnaissent à peine. Le monde idéal est une libre création de l'âme, le produit de l'inspiration poétique." (Examen crit. v. iv. p. 324—332).

[310] (p. 330.)—Acosta, lib. i. cap. 5. Compare my Relation historique, vol. i. p. 209. As the stars α and γ of the Southern Cross have almost the same ascension, the Cross appears to be perpendicular in passing through the meridian; but the natives forget too frequently that this time comes every day about $3' 56''$ sooner. All the reckonings respecting the visibility of the Southern Cross which I have brought forward

are due to the friendly communications of Dr. Galle, who first found the planet Le Verrier in the sky. "The uncertainty of the calculation according to which the star α of the Southern Cross, allowing for refraction, began to be visible in 52° 25′ south latitude about the year 2,900 B.C., may perhaps amount to more than 100 years, but it cannot be determined, even with the strictest mode of reckoning, because the actual movement of the fixed stars is not similar throughout so long an interval of time. The movement of α Crucis is about $\frac{1}{3}$ of a second annually, chiefly in right ascension. We may expect from the uncertainty produced by want of care, that the interval does not exceed that time."

311 (p. 332.)—Barros, da Asia, Dec. i. lib. iv. cap. 2, (1778), p. 282.

312 (p. 332.)—Navarrete, Coleccion de los Viages y Descubrimientos que hiciéron por mar los Españoles, vol. iv. p. xxxii. (in the *Noticia biografica de Fernando de Magallanes.*)

313 (p. 333.)—Barros, Dec. iii. Pt. ii. 1777, p. 650 and 658—662.

314 (p. 334.)—The Queen writes to Columbus: "Nosotros mismos, *y no otro alguno,* habemos visto algo del libro que nos dejástes (a journal in which the suspicious seaman had omitted all numerical accounts of degrees of latitude and of distances); quanto mas en esto platicamos y vemos, conocemos cuan gran cosa ha seido este negocio vuestro y que habeis sabido en ello mas que nunca se pensó que pudiera saber ninguno de los nacidos. Nos parece que seria bien que levásedes con vos un buen Estrologo, y nos parescia que seria bueno para esto Fray Antonio de Marchena, porque es buen Estrologo, y siempre nos pareció que se conformaba con vuestro parecer." Respecting this Marchena, who is identical with Fray Juan Perez, the guardian of the Monastery of la Rabida, at which Columbus, in his poverty in 1484, begged of the monks "bread and water for his child," *vide* Navarrete, vol. ii. p. 110, vol. iii. p. 597 and 603, (Muñoz, Hist. del Nuevo Mundo, lib. iv. §. 24). Columbus calls the Astronomical Ephemerides a *vision profetica* in a letter to the *Christianissimos Monarcas* from Jamaica, dated the 7th of July, 1503, (Navarrete, vol. i. p. 306).—The Portuguese astronomer Ruy Falero, a native of Cubilla, was named in 1519, at the same time with Magellan, as *Caballero de la Orden de Santiago,* and played an important part in making the preparations for Magellan's voyage round the world. He had prepared a treatise of his own, respecting the determination of the longitude.

for Magellan; of which the great historian, Barros, possessed some manuscript chapters; (Examen crit. vol. i. p. 276 and 302, vol. iv. p. 315); they were probably the same which were printed in 1535 by Johann Cromberger at Seville. Navarrete (Obra póstuma sobre la Hist. de la Nautica y de las ciencias matematicas, 1846, p. 147), could not find the book even in Spain. Respecting the former methods of determining the longitude, which Falero possessed by the gift of his *Demonio familiar*, *vide* Herrera, Dec. ii. lib. ii. cap. 19, and Navarrete, vol. v. p. lxxvii. Afterwards, Alonso de Santa Cruz, the Cosmographer, who (like Felipe Guillen the apothecary of Seville in 1525) attempted to determine the longitude by the variation of the magnetic needle, made impracticable proposals to arrive at the same end by *transferring the time;* but his chronometers were hour-glasses, made with sand and water, wheel-work moved by weights, and even wicks dipped in oil, which burnt out in an equal space of time! Pigafetta (Transunto del Trattato di Navigazione, p. 219) recommends the height of the moon in the meridian. Amerigo Vespucci says very simply and truly with respect to the known method of finding the longitude, "the advantage which it affords, arises from the *corso più leggier de la luna*," (Canovai, Viaggi, p. 57).

315 (p. 336.)—The American race of mankind, extending from 65° north to 55° south latitude, did not pass from the life of hunters to that of agriculturists, through the intermediate stage of shepherds. This circumstance is more remarkable, because the bisons which wander about in common herds are capable of being tamed and produce much milk. The account seen in Gamara (Hist. gen. de las Indias, cap. 214) that to the north-west of Mexico in the 40th degree of latitude, there was a nation in the 16th century whose chief riches consisted in herds of tamed bisons (*bueyes con una giba*) is but little regarded. From these animals the natives obtained materials for clothing, food and drink, probably blood, (Prescott, Conquest of Mexico, vol. iii. p. 416); for the objection, or at any rate, a disinclination to make use of milk, seems, before the arrival of the Europeans, to have been common to all the natives of the New Continent, as well as to the inhabitants of China and Cochin-China. There were, however, herds of tame llamas in the mountainous districts of Quito, Peru and Chili. These herds were the riches of people who were settled and employed in the cultivation of the soil; in the Cordilleras of South America there

were no shepherds and no nomad life. What were the "tamed stags" in the Punta da St. Helena, which I find mentioned in Herrera, Dec. ii. lib. x. cap. 6, (vol. i. p. 471, ed. Amberes 1728)? These deer are said to have produced milk and cheese; *cierros que dan leche y queso y se crian en casa!* From what source is this notice obtained? It cannot have arisen from any confusion with the llamas without horns, belonging to the cold mountainous regions; of these, Garcilaso (Comment. reales, Pt. i. lib. v. cap. 2, p. 133) supposes that they were used in Peru for ploughing, especially in the highlands of Collao. (Compare also Pedro de Cieça de Leon, *Chronica del Peru*, Sevilla, 1553, cap. 110, p. 264). This use of the animals appears to be a rare exception, and a local custom merely; for, generally speaking, the American races of mankind were characterized by a want of domestic animals, and this had considerable influence upon their domestic life.

[316] (p. 337.)—Respecting the hope which Luther principally rested upon the rising generation, the youth of Germany, in bringing out his grand free-spirited work, *vide* the remarkable expressions which he used in a letter of the month of June, 1518, (Neander, *de Vicelio* p. 7).

[317] (p. 338.)—I have elsewhere shown how the knowledge of the date at which Amerigo Vespucci was appointed the royal chief pilot alone refutes the charge first made by Schoner, the astronomer of Nuremberg, in 1533, that Vespucci craftily inserted the words *Terra di Amerigo* in the map of the coasts which he altered. The high estimation, in which the Spanish Court held the hydrographic and astronomical knowledge of Amerigo Vespucci, is very evident from the papers given to him (*Real titulo con extensas facultades*), when he was made *Piloto mayor* on the 22nd of March, 1508, (Navarrete, vol. iii. p. 297—302). He was placed at the head of a true *Deposito hydrografico*, and had to prepare for the *Casa de Contratacion* in Seville, the central point of all their maritime undertakings, a general description of the coasts, and a catalogue of places, (*Padron general*) in which all new discoveries were annually added. In 1507 the name *America terra* was applied to the New Continent by a man whose existence was certainly unknown to Vespucci, namely, the geographer Waldseemüller (Martinus Hylacomylus) of Freiburg in Breisgau, the director of a printing establishment in St. Dié in Lorraine, in a little description of the world entitled "Cosmographiæ Introductio, insuper quatuor Americi Vespucii Navigationes," (impr.

in oppido S. Deodati, 1507). Ringmann, Professor of Geography at Basle (better known under the name of Philesius), Hylacomylus and the Father Gregorius Reisch, editor of the *Margarita philosophica*, were intimate friends. In the latter work is a treatise on Architecture and Perspective, of the date 1509, (Examen crit. vol. iv. p. 112). Laurentius Phrisius in Metz, a friend of Hylacomylus, and patronized by the Duke Renatus of Lorraine, who corresponded with Vespucci, alludes to Hylacomylus, in the Strasburg edition of Ptolemæus of 1522, as being dead. The map of the New Continent marked down in this edition gives the name *America* for the first time, (in an edition of the Geography of Ptolemæus). Nevertheless according to my inquiries, a map of the world by Petrus Apianus had appeared two years earlier, which is added to Camer's edition of Solinus, and afterwards by the Vadian edition of Mela, and this, like the more recent Chinese maps, represents the isthmus of Panama as divided (Examen. crit. vol. iv. p. 99—124, vol. v. p. 168—176). The map from the library of Ebner at Nuremberg (of the date 1527) which is now at Weimar, and a different one of Diego Ribero, engraved by Güssefeld (1529), were formerly erroneously considered to be the most ancient maps of the New Continent (op. cit. vol. ii. p. 184, vol. iii. p. 191). Vespucci visited with Juan de la Cosa, in the expedition of Alonso de Hojeda (1499) the coasts of South America, a year after Columbus's third voyage; Juan de la Cosa's map, made in *Puerto de Santa Maria* in 1500, six years before the death of Columbus, was first made known by me. Vespucci could have had no object in feigning a journey of the year 1497, for he, as well as Columbus, was completely convinced, even until his death, that they had reached an eastern part of Asia, (compare the letter of Columbus to Pope Alexander VI of Feb. 1502, and another to the Queen Isabella of July 1503 in Navarrete, vol. i. p. 304, vol. ii. p. 280, and Vespucci's letter to Pier Francesco de Medici in Bandini, *Vita e Lettera di Amerigo Vespucci*, p. 66 and 83). Pedro de Ledesma, Columbus's pilot in his 3rd voyage, said in 1513 in the legal proceedings against his heirs, that they considered Paria to be a part of Asia, *la tierra firme que dicese que es de Asia;* Navarrete, vol. iii. p. 539. The frequently used phrases *Mondo nuovo, alter Orbis, Colonus novi orbis repertor* do not contradict this, for they allude to regions never before seen, and were in the same way used by Strabo, Mela, Tertullian, Isidor of Seville and Cadamosto (Examen. crit. vol. i. p. 118, vol. v. p. 182—184). For more than 20 years after the death of Vespucci,

which happened in 1512, and even until the calumnies published by Schoner in the *Opusculum geographicum* in 1533, and by Servet in the Lyon's edition of the Geography of Ptolemæus, there were no complaints made against the Florentine mariner? Christopher Columbus, calls him a year before his death, a man "of the most blameless character (*mucho hombre de bien*), as worthy of all confidence, and always inclined to be useful to him," (*Carta à mi muy caro fijo D. Diego* in Navarrete, vol. i. p. 351). Other authors were equally well disposed towards Vespucci; namely, Fernando Colon, who published the life of his father about 1535, four years before his death, and who with Juan Vespucci, the nephew of Amerigo, 1524, was present at the astronomical Junta at Badajoz, and the treaties respecting the possession of the Moluccas:—Petrus Martyr de Anghiera, the personal friend of the Admiral, whose correspondence reaches as late as 1525:—Oviedo, who sought out for everything to lessen Columbus's fame; Ramusio and the great historian Guicciardini. If Amerigo had wished intentionally to falsify the dates of his voyages, he would have brought them to coincide properly, so that the first voyage would not have ended five months after the commencement of the second. The errors in numbers in the numerous translations of his voyages are not to be ascribed to him, for he himself did not publish these reports. Similar errors in numbers were also very usual in the printed works of the 16th century. Oviedo, in his capacity of Page to the Queen, was present at the audience in which Ferdinand and Isabella received with great pomp at Barcelona in 1493, the Admiral after his return from his first voyage. He thence had it printed, that the audience took place in 1496, and that America was discovered in 1491. Gomara printed it, not with figures, but in words, and places the discovery of the *Tierra firma* of America in 1497, and therefore, exactly in the year which is so important in establishing the character of Amerigo Vespucci, Examen crit. vol. v. p. 196—202). The legal proceeding extending from 1508 to 1527, instituted against the heirs of Christopher Columbus to deprive them of the privileges and rights with which the Crown had invested the Admiral in 1492, is a strong confirmation of the guiltless behaviour of the Florentine sailor, who never attempted to give his name to the New Continent, but who was unfortunate enough to attract more of the attention of his posterity to him than he really deserved, in consequence of his boasting in the reports made to the Gonfaloniere Piero Soderini, to Pierfrancesco de' Medici, and to the Duke Rena-

tus II of Loraine. Amerigo entered the service of the State as *Piloto mayor* in the same year in which the trial commenced. He lived four years in Seville, whilst the process was going on to determine what part of the New Continent had been first touched by Columbus. The most wretched reports were listened to, and served as a subject of accusation. Witnesses were sought out in Santo Domingo, and all the Spanish havens, in Moguer, Palos and Seville, under the eyes of Amerigo Vespucci, and his nephew Juan. The *Mundus Novus*, printed by Johann Otman, at Augsburg, in 1504, the *Raccolta di Vincenza* (Mondo Novo e paesi novamente retrovati da Alberico Vespuzio Fiorentino), by Alessandro Zorzi (1507), generally attributed to Fracanzio di Montalboddo, and the *Quatuor Navigationes* of Martin Waldseemüller (Hylacomylus) had already appeared. In 1520, there were maps of the world, containing the name 'America,' which Hylacomylus proposed in 1507, and which Joachim Vadianus praised in 1512, in a letter from Vienna to Rudolph Agricola; and yet the man to whom, in the account of a voyage to Paria, well known in Germany, France, and Italy, was ascribed, in 1497, was was neither personally called upon by the lawyers, in the trial which was commenced in 1508, and lasted nineteen years, nor was he named as a predecessor or opponent of Columbus. After the death of Amerigo Vespucci (on the 22nd Feb. 1512, at Seville), why was not his nephew, Juan Vespucci, as well as Martin Alonzo, and Vincente Yanez Pinzon, Juan de la Casa and Alonso de Hojeda, called upon to prove that the coast of Paria, which was so valuable, not as being "the Continent of Asia," but because of the vicinity to a productive pearl-fishery, had been reached by Amerigo before the time of Columbus, that is, before the 1st of August, 1498? This neglect of important testimony is inexplicable, if Amerigo Vespucci had boasted that he made a voyage of discovery in 1497, or if any true confidence had been imposed in the falsified dates and typographical errors of the *Quatuor Navigationes*. The great work of a friend of Columbus, Fray Bartholomé de las Casas, which is not yet printed (Historia general de las Indias), was written, as we distinctly know, in different parts, at very different times. It was commenced fifteen years after the death of Amerigo (in 1527), and was completed in 1559, seven years before the death of its gray-haired author, in the 92nd year of his age. Praise and bitter complaint are wonderfully mixed up in it. We see that hate and suspicion of deception increase, the more widely the fame of the Florentine sailor was

diffused. In the preface, which was written first (*Prologo*) it is said; "Amerigo relates what he has undertaken in two journeys to our Indies; yet he appears to keep many things secret, whether it was intentional (*á saviendas*), or because he did not observe them. Hence, some have ascribed to him discoveries belonging to others, from whom they should not be taken away." The opinions uttered in lib. i. cap. cxl. are equally constrained; "I must here mention the injustice which Amerigo, or those who had his "Quatuor Navigationes" printed, (ó los que imprimiéron), were guilty of towards the admiral. To him alone, without mentioning others, the discovery of the mainland was attributed. He is said to have placed the name of *America* upon the maps, and in this way to have erred against the admiral. As Amerigo was a linguist, and knew how to write elegantly (era latino y eloquente), he represented himself as the leader of the expedition of Hojeda, in a letter to the King Renatus; he was, however, only one of the steersmen, although experienced in a sea-faring life, and learned in geography, (hombre entendido en las cosas de la mar y docto en Cosmographia). . . . . It has been reported throughout the world that he was the first on the New Continent. If he has purposely spread this wicked report, it is a great wickedness; and even if he had no actual intention, it at any rate looks very much like it, (clara pareze la falsedad: y si fué de industria hecha, maldad grande fué; y ya que no lo fuese, al menos parezelo). . . . . Amerigo is said to have started upon his voyage in the year 7 (1497): an account which certainly appears only to be an error in writing, and not a malicious deception (pareze aver avido yerro de pendola y no malicia), for he was to return in eighteen months. Foreign writers call the land America. It ought to be called Columbia." He says: "an tomado los escriptores extrangeros de nombrar la nuestra Tierre firme America, como si Americo solo y no otro con él y antes que todos la oviera descubierto." In lib. i. cap. 164—169, and lib. ii. cap. ii. the whole hate suddenly bursts forth. It is no longer ascribed to a mere mistake in the numbers of the years, or to preference shown to Amerigo by strangers; all is intentional deceit, of which Amerigo was himself guilty, (de industria lo hizo . . . . persistió en el engaño . . . . de falsedad está claramente convencido.) Bartholomé de las Casas takes the trouble to prove that in both passages of Amerigo, he has falsified the sequence of the order of events in his reports of the two first voyages, and has laid down many things as happening in his first voyage, which

occurred in the second, and *vice versâ.* It is remarkable to me, that the accuser did not appear to have felt how much the weight of his accusation was lessened by his speaking of the opposite opinion, and the indifference entertained by one who felt the most lively interest in attacking Amerigo, if he had supposed him to be guilty and hostile to his father. "I am astonished," says Las Casas, "that Hernando Colon, a man of great acuteness, when he had in his hands the report of Amerigo's voyages, (as I distinctly know that he had), did not notice in it deceit and injustice towards the admiral." As some months ago, I again had an opportunity of examining the rare manuscripts of Bartholomé de las Casas, I wish to introduce into this long note, the ideas of which I made no use in the year 1839, (Examen crit. vol. v. p. 178—217), respecting an historical matter of so great importance, which has hitherto been so imperfectly discussed. The conviction which I then expressed (p. 217 and 224) has remained unshaken. "Quand la dénomination d'un grand continent, généralement adoptée et consacrée par l'usage de plusieurs siècles, se présente comme un monument de l'injustice des hommes, il est naturel d'attribuer d'abord la cause de cette injustice à celui qui semblait le plus intéressé à la commettre. L'étude des documens a prouvé qu'aucun fait certain n'appuie cette supposition, et que le nom d'Amérique, a pris naissance dans un pays éloigné (en France et en Allemagne), par un concours d'incidens qui paraissent écarter jusqu'au soupçon d'une influence de la part de Vespuce. C'est là que s'arrête la critique historique. Le champ sans bornes des causes *inconnues,* ou des combinaisons morales *possibles*, n'est pas du domaine de l'histoire positive. Un homme qui pendant une longue carrière a joui de l'estime des plus illustres de ses contemporains, s'est élevé par ses connaissances en astronomie nautique, distinguées pour le temps où il vivait, à un emploi honorable. Le concours de circonstances fortuites lui a donné une célébrité dont le poids, pendant trois siècles, a pesé sur sa mémoire, en fournissant des motifs pour avilir son caractère. Une telle position est bien rare dans l'histoire des infortunes humaines; c'est l'exemple d'une flétrissure morale croissant avec l'illustration du nom. Il valait la peine de scruter ce qui, dans ce mélange de succès et d'adversités, appartient au navigateur même, aux hazards de la rédaction précipitée de ses écrits, ou à de maladroits et dangereux amis." Copernicus himself, added to this dangerous report; for he also attributes the discovery of the New Continent to Vespucci. In speaking of the "*centrum gravitatis,*" and "*cen-*

trum magnitudinis," of the dry land, he adds, "magis id erit clarum, si addentur insulæ ætate nostra sub Hispaniarum Lusitaniæque Principibus repertæ et præsertim America ab inventore denominata navium præfecto, quem, ob incompertam ejus adhuc magnitudinem, alterum orbem terrarum putant." (Nicolai Copernici de Revolutionibus orbium cœlestium Libri, sex, 1543, p. 2, *a*.)

318 (p. 338.)—Compare my Examen crit. de l'hist. de la Géographie vol. iii. p. 154—158 and 225—227.

319 (p. 341.)—Compare Kosmos, vol. i. p. 88.

320 (p. 341.)—"The telescope which Galileo himself made, and others of which he made use, in watching the Satellites of Jupiter, the phases of Venus and the spots on the sun, had, by degrees, a magnifying power of four, seven, and thirty-two (linear), but never more." Arago in Annuaire du Bureau des Long. pour l'an 1842, p. 268.

321 (p. 342.)—Westphal, in his Biography of Copernicus, dedicated to the great astronomer of Königsberg, Bessel (1822, p. 33), like Gassendi, calls the Bishop of Ermland, Lucas Watzelrodt von Allen. From recent explanations, for which I have to thank the learned Prussian historian, the director of the Archives, Voigt, "the family of Copernicus's mother was originally Weiselrodt, Weisselrot, Weisebrodt, but usually called Waisselrode, and was originally distinct from the family of the Von Allens, who flourished at Thorn, since the beginning of the 15th century, and who obtained the additional name of Von Allen, probably by adoption, or some nearer relationship." Sniadecki and Czynski, (Kopernik et ses travaux, 1847, p. 26) call the mother of the great Copernicus, Barbara Wasselrode whom the father of a Bohemian family had married at Thorn in 1464. The astronomer's name (called by Gassendi, *Tornæus Borussus*) is written by Westphal and Czynski "Köpernik," by Krzyzanowski "Kopirnig." In a letter of Martin Cromer, Bishop of Ermland, from Heilsberg, of a date of Nov. 21, 1580, he says; "Cum Jo. (Nicholaus) Copernicus vivens ornamento fuerit atque etiam nunc post fata sit, non solum huic Ecclesiæ, verum etiam toti Prussiæ patriæ suæ, iniquum esse puto, eum post obitum carere honore sepulchri sive monumenti."

322 (p. 342.)—Thus Gassendi adds to the description of Tycho's life, in *Nicolai Copernici vitâ*, (Tychonis Brahei vita) 1655. Haga Comitum, p. 320; "eodem die et horis non multis priusquam animam efflaret." Only Schubert, in his astronomy, pt. i. p. 115, and Robert Small, in the very

learned "Account of the Astronomical discoveries of Kepler," 1804, p. 92, suppose that Copernicus died "a few days after the appearance of his work." This is also the opinion of Voigt, the director of the Archives, at Königsberg; because, in a letter which George Donner, Canon of Ermland, wrote to the Duke of Prussia, shortly after the death of Copernicus, he says, "the venerable and worthy Doctor Nicholas Koppernick has had his work published shortly before the days of his release from misery, like the sweet song of a dying swan." According to the common idea (Westphal, Nicholas Copernicus, 1822, p. 73 and 82), the work was begun in 1507 and so far completed in 1530, that afterwards, only a few corrections were necessary. The publication of the work was hastened by a letter from Cardinal Schonberg, written from Rome, in November 1536. The cardinal wished to have the manuscript copied off for him by Theodore von Reden, and sent to him. Copernicus himself, in his dedication to Pope Paul III. says, that the time at which he had worked at the book had extended to the *quartum novennium.* If we think of the long time then required to print a work of 400 pages, and that the great man died in 1543, we must suppose that the dedication was not written in the year last named; hence for the beginning of the work, (by reckoning back thirty-six years), we have an earlier, and not a later date than 1507. Voigt doubts whether the water-works at Frauenberg, generally attributed to Copernicus, could have been laid down according to his plan. He has discovered, that in 1571, a contract was first entered into between the chapter of the cathedral and "the ingenious Master Valentine Zendel, master of the pipes of Breslau," to bring the water from the mill-pond at Frauenberg into the dwellings of the canons. There is no mention made of any earlier plan of conducting the water. Thus the present one was set on foot twenty-eight years after the death of Copernicus.

[323] (p. 343.)—Delambre, Histoire de l'Astronomie moderne, vol. i. p. 140.

[324] (p. 343.)—Neque enim necesse est, eas hypotheses esse veras, imo ne verisimiles quidem, sed sufficit hoc unum, si calculum observationibus congruentem exhibeant; Preface to Osiander. "The Bishop of Culm, Tidemann Gise, born at Dantzig, oppressed Copernicus on account of the publication of his work, and at last obtained the manuscript with the commission to promote the printing of it. He first sent it to Rhæticus, Professor at Wittenberg, who shortly before had been living

with his tutor at Frauenburg. Rhæticus thought Nuremberg the best place for publishing it, and committed the care of the printing to Professor Schoner and Andreas Osiander." (Gassendi, Vita Copernici, p. 319.) The words of praise which are introduced at the end of the Preface to the work of Copernicus, prove, without the express testimony of Gassendi, that the Preface was written by a strange hand. Also, upon the title-page of the first edition, namely that printed at Nuremberg, in 1543, Osiander added the expression, carefully avoided in the writings of Copernicus, "motus stellarum novis insuper ac admirabilibus hypothesibus ornati;" and also, the indelicate sentence, "igitur, studiose lector, eme, lege, fruere." In the second edition (published at Basle, in 1566), which I have very carefully compared with the first Nuremberg edition, no further mention is made upon the title page of the "admirable hypotheses;" but Osiander's "Præfatiuncula de hypothesibus hujus operis," as Gassendi calls the preface that was inserted, is retained. However, it is also evident, from the fact, that Osiander calls the dedication to Paul III. the *Præfatio Authoris*, that he wished, without meaning himself, to indicate that the Præfatiuncula was by a strange hand. The first edition has only 196 leaves, the second, 213, on account of the addition of the *Narratio prima*, of the astronomer Joachim Rhæticus, a narrative letter directed to Schoner, which, as I have already remarked in the text, was hastened in the printing at Basle, by the mathematician Gassarus, and gave the learned world the first knowledge of the Copernican system. Rhæticus himself gave up his Professorship at Wittenberg, in 1539, in order to enjoy the instruction of Copernicus. (Compare, respecting these relations, Gassendi, p. 310—319.) The explanation of the addition which Osiander thought he was obliged to make, through fear, is given in Gassendi. "Andreas porro Osiander fuit, qui non modo operarum inspector (the overseer of the printing), fuit, sed Præfatiunculam quoque ad lectorem (tacito licet nomine) de Hypothesibus operis adhibuit. Ejus in ea consilium fuit, ut, tametsi Copernicus Motum Terræ habuisset, non solum pro Hypothesi, sed pro vero etiam placito; ipse tamen ad rem, ob illos, qui heine offenderentur, leniendam, excusatum eum faceret, quasi talem Motum non pro dogmate, sed pro Hypothesi mera assumpsisset."

225 (p. 346.)—Quis enim in hoc pulcherrimo templo lampadem hanc in alio vel meliori loco poneret, quam unde totum simul possit illuminare? Siquidem non inepte quidam lucernam mundi, alii mentem, alii rectorem vocant. Trimegistus visibilem Deum, Sophoclis Electra intuentem

omnia. Ita profecto tanquam in solio regali Sol residens circumagentem gubernat Astrorum familiam; Tellus quoque minime fraudatur lunari ministerio, sed ut Aristoteles de animalibus ait, maximam Luna cum terra cognationem habet. Concipit interea a Sole terra, et impregnatur annuo partu. Invenimus igitur sub hac ordinatione admirandam mundi symmetriam ac certum harmoniæ nexum motus et magnitudinis orbium; qualis alio modo reperiri non potest. (Nichol. Copernic. de Revol. orbium cœlestium, lib. i. cap. x. p. 9, *b.*) In this passage, which is not without poetic spirit and elevated expressions, we find, as in all astronomical works of the 17th century, traces of a long and close intercourse with classical antiquity. Copernicus had in his thoughts these passages; Cic. Somn. Scip. cap. iv. Plin. ii. 4, and Mercur. Trismeg. lib. v. (ed. Cracov. 1586), p. 195 and 201. The allusion to the Electra of Sophocles is obscure, as the sun is never called exactly "all-seeing" in it, as is the case in the Iliad and Odyssey, and in the Chœphoræ of Æschylus (v. 980), which Copernicus could not well have called the Electra. According to Böckh's supposition, the allusion is rather to be ascribed to a fault of memory, and is a consequence of an obscure recollection of the verse 869 of the Œdipus Coloneus of Sophocles. It is very remarkable, that quite recently, in an otherwise learned work (Czynski, Copernik et ses travaux, 1847, p. 102), the *Electra* of the Tragedian has been confounded with *electrical stream.* As a translation of the passage of Copernicus above alluded to; "Si on prend le soleil pour le flambeau de l'Univers, pour son âme, pour son guide, si Trimegiste le nomme un Dieu, si Sophocle le croit une puissance électrique qui anime et contemple l'ensemble de la création. . . ."

[326] (p. 346.)—"Pluribus ergo existentibus centris, de centro quoque mundi non temere quis dubitabit, an videlicet fuerit istud gravitatis terrenae, an aliud. Equidem existimo, gravitatem non aliud esse, quam appetentiam quandam naturalem partibus inditam a divina providentia opificis universorum, ut in unitatem integritatemque suam sese conferant in formam globi coëuntes. Quam affectionem credibile est etiam Soli, Lunæ, cæterisque errantium fulgoribus inesse, ut ejus efficacia in ea qua se repræsentant rotunditate permaneant, quæ nihilominus multis modis suos efficiunt circuitus. Si igitur et terra faciat alios, utpote secundum centrum (mundi), necesse erit eos esse qui similiter extrinsecus in multis apparent, in quibus invenimus annuum circuitum.—Ipse denique Sol medium mundi putabitur possidere, quæ omnia ratio ordinis, quo illa

sibi invicem succedunt, et mundi totius harmonia nos docet, si modo rem ipsam ambobus (ut ajunt) oculis inspiciamus." Copern. de Revol. orb. cœl. lib. i, cap. 9, p. 7, *b*.

327 (p. 346.)—Plut. de facie in orbe Lunæ, pag. 923 *c*. (Compare Ideler, Meteorologia veterum Græcorum et Romanorum, 1832, p. 6). In the passage of Plutarch, Anaxagoras is not mentioned; but that he applies the same theory "of falling upon the cessation of the revolving motion" to all (stony) heavenly bodies, is proved by Diog. Laert. ii. 12, and by many passages which I have above collected (Kosmos, vol. i. p. 142, 401, 405 and 411). Compare also Aristot. de Cœlo ii, 1 p. 284, *a* 24 Bekker, and a remarkable passage of Simplicius, p. 491, *b* in the Scholia, according to the edition of the Berlin Academy, where the heavenly bodies are alluded to as "not falling down, when the revolving force predominates over the falling power, or the force of attraction downwards." An example quoted (loc. cit.) from Simplicius is connected with these ideas, which at any rate partly belong to Empedocles and Democritus, and partly to Anaxagoras; Simplicus says, "that the water in a phial will not be poured out if it is turned rapidly, provided the revolving motion is quicker than the tendency of the water downwards, τῆς ἐπὶ τὸ πάτω τοῦ ὕδατος φορᾶς."

328 (p. 346).—Kosmos, vol. i. p. 142 and 410. (Compare Letronne des Opinions cosmographiques des Pères de l'Eglise in the Revue des deux Mondes, 1834, vol. i. p. 621).

329 (p. 347).—*Vide* the collection of all the passages in ancient writers which refer to attraction, weight and the falling of bodies, in the laborious and intelligent work of Th. Henri Martin, Etudes sur le Timée de Platon, 1841, vol. ii. p. 272—280 and 341.

330 (p. 347).—Joh. Philoponus de creatione mundi, lib. i. cap. 12.

331 (p. 347).—He afterwards gave up the right notion, (Brewster, Martyrs of Science, 1846, p. 211); but Kepler in the "Harmonice Mundi," completed as early as 1618, expresses his opinion that there is a power in the central body of the planetary system, the sun, which rules over the movements of the planets, and that this solar power decreases either as the square of the distance or in direct ratio with it.

332 (p. 347).—Kosmos, vol. i. p. 31 and 60.

333 (p. 347.)—Op. cit. vol. ii. p. 134 and 205—206. Besides the dedication, the scattered passages in the works of Copernicus which refer to the systems of the structure of the universe before the time of

Hipparchus are the following; lib. i. cap. 5 and 10, lib. v. cap. 1 and 3, (ed. princ. 1543, p. 3, *b*; 7, *b*; 8, *b*; 133, *b*; 141 and 141, *b*; 179 and 181, *b*). Everywhere Copernicus shows a predilection and a close acquaintance with the Pythagoreans, or rather, to express it more correctly, with what was attributed to the eldest of them. He knew, for example, as the beginning of his dedication shows, the letter of Lysis to Hipparchus, which certainly proves that the mysterious Italian school, "as at the beginning it was Copernicus' intention," would only communicate their opinions to their friends. The age of Lysis is somewhat uncertain; he is at one time called an immediate scholar of Pythagoras, at another, and more certainly, a teacher of Epaminondas (Böck, Philolaos, p. 8—15). The letter of Lysis to Hipparchus, an old Pythagorean, who had published the secrets of their society, was fabricated in later times, as is the case with many other writings. Copernicus probably knew his writings from the collection of Aldus Manutius, Epistolæ diversorum philosophorum (Romæ, 1494), or from the Latin translation by Cardinal Bessarion (Venet. 1516). In the prohibition of the work of Copernicus, 'de Revolutionibus,' in the famous decree of the *Congregazione dell' Indice*, of March 5, 1616, the new system of the universe was expressly called "falsa illa doctrina Pythagorica, Divinæ Scripturæ omnino adversans." The important passage upon Aristarchus of Samos, of which I have spoken in the text, is in the 449th page of *Arenarius* in the Paris edition of Archimedes of 1615, by David Rivaltus. The *Editio princeps* was printed at Basle by Io. Hervagius, in 1544. The passage in Arenarius says distinctly, "Aristarchus refutes the opinions of astronomers who place the earth invariably in the centre of the universe. The sun represents the centre and is immovable like other stars, whilst the earth revolves round it." In the work of Copernicus, Aristarchus is mentioned twice (p. 69 *b*, and 79) without any reference to his astronomical system. Ideler asks (Wolf's and Buttmann's Museum of ancient Science, vol. ii. 1808, p. 452) whether Copernicus was acquainted with the writing of Nicholas of Cusa entitled 'de docta ignorantia.' The first Paris edition of this work was certainly in 1514, and the expression: "*jam nobis manifestum est terram in veritate moveri,*" out of the mouth of a philosophizing Cardinal might have made some impression upon the Canon of Frauenburg (Whewell, Philosophy of the inductive Sciences, vol. ii. p. 343); but a fragment from the hand of Cusa, lately discovered by Clemens (1843) in the library

at the hospital of Cues, is a sufficient proof, as well as the work '*de Venatione Sapientiæ*,' cap. 28, that Cusa did not imagine that the earth moved round the sun, but that it moved with it, but more slowly "round the continually changing pole of the world." (Clemens in Giordano Bruno and Nichol. von Cusa, 1847, p. 97—100).

[384] (p. 348.)—*Vide* the complete treatise on this subject in Martin, 'Etudes sur Timée,' vol. ii. p. 111, (Cosmographie des Egyptiens) and p. 129—133 (Antécédents du Système de Copernic). The supposition of this learned philologist, according to which the original system of Pythagoras is different from that of Philolaus, and places the earth immovably in the centre, does not appear to me altogether convincing (vol. ii. p. 103 and 107). Respecting the striking supposition of Gassendi upon the Tychonic system of Apollonius of Perga, which I have alluded to in the text, I will here explain myself more clearly. It says in the Biography of Gassendi: "Magnam imprimis rationem habuit Copernicus duarum opinionum affinium, quarum unam Martiano Capellæ, alteram Apollonio Pergaeo attribuit.—Apollonius Solem delegit, circa quem, ut centrum, non modo Mercurius et Venus, verum etiam Mars, Jupiter, Saturnus suas obirent periodos, dum Sol interim, uti et Luna, circa Terram, ut circa centrum, quod foret Affixarum mundique centrum, moverentur; quæ deinceps quoque opinio Tychonis propemodum fuit. Rationem autem magnam harum opinionum Copernicus habuit, quod utraque eximie Mercurii ac Veneris circuitiones repræsentaret, eximieque causam retrogradationum, directionum, stationum in iis apparentium exprimeret et posterior (Pergæi) quoque in tribus Planetis superioribus præstaret," (Gassendi, Tychonis Brahei vita, p. 296). My friend, Galle, the astronomer, from whom I requested information, finds like myself nothing to justify Gassendi's definite supposition. He writes thus: "The passages which you have pointed out to me in the Almagest of Ptolemæus (at the beginning of Book xii.) and in the works of Copernicus (lib. v. cap. 3, p. 141, *a*, cap. 35, p. 179, *a* and *b*, cap. 36, p. 181, *b*), only allude to the retrogression and stationary condition of the planets, and thus point at the assumption of Apollonius regarding the revolution of the planets round the sun, for Copernicus himself expressly mentions the notion that the earth is stationary; but whence the latter obtained what he brought forward about Apollonius, cannot be determined. It was only upon later authority that we can attribute to Apollonius of Perga the establishment

of a system like that of Tycho, and I do not find a clear representation of this system either mentioned by Copernicus himself, nor quoted from any other place. If the 12th book of the Almagest is the only source, whence a perfect idea of the Tychonic system has been attributed to Apollonius, we must believe that Gassendi has gone too far in his suppositions, and that in this particular it is the same as with the phases of Mercury and Venus which Copernicus (lib. i. cap. 10, p. 7, *b.* and 8, *a*) mentions without applying them decidedly to his system. It is probable that Apollonius treated in a similar way of the explanation of the apparent retrogression of the planets (mathematically) by the supposition of a revolution round the sun, without anything distinct or general respecting the truth of the notion. The difference between the Apollonian system as described by Gassendi, and that described by Tycho, was that the latter also explains the inequalities of the motions. The remark of Robert Small, that the idea which forms the basis of Tycho's system was by no means unknown to the spirit of Copernicus, but rather served him as a transition point to arrive at his own system, appears to me to be well founded.

[335] (p. 349.)—Schubert, Astronomie, Pt. i. p. 124. A successful and complete view of all the astronomical ideas of the universe from the earliest ages of mankind to Newton's theory of gravitation (Inductive Table of Astronomy) is given in Whewell's Philosophy of the Inductive Sciences, vol. ii. p. 282.

[336] (p. 349.)—Plato in the Phædrus agrees with Philolaus; in the Timæus on the other hand he coincides with the notion of the earth resting immovably in the centre, which was afterwards called the theory of Hipparchus and Ptolemæus, (Böckh, de Platonico Systemate cœlestium globorum, et de vera indole Astronomiæ Philolaicæ, p. xxvi.—xxxii.; the same author on Philolaus, p. 104—108. Compare also Fries, History of Philosophy, vol. i. p. 325—347, with Martin's 'Etudes sur Timée,' vol. ii. p. 64—92). The astronomical vision in which the universe is enveloped at the end of the Book upon the Republic, reminds us at the same time of the system of the planets supposed to be spheres contained, one within the other, and the harmony of the tones, "like the voices of revolving Sirens." (*Vide* respecting the discovery of the true system of the universe, the beautiful and comprehensive work of Apelt: Epochs of the History of Man, vol. i. 1845, p. 205—305 and 379—445).

[337] (p. 349.)—Kepler, Harmonices Mundi, libri quinque, 1619, p. 189.

"On the 8th of March, 1618, after many vain attempts, Kepler hit upon the idea of comparing the square of the time of the revolution of the planets with the cube of the average distance, but he made a mistake in calculation and discarded the notion again. On the 15th of May, 1618, he came to the idea again, and calculated correctly. The third of Kepler's laws was now discovered." This discovery and those allied o it, happened in that unlucky time when this man, who was exposed to the hardest blows of destiny from his earliest childhood, was working during a trial for witchcraft which lasted six years, to save his mother, who was 70 years of age, and who was accused of mixing poisons, and of sorcery, from the torture and executioner. The suspicion was strengthened because her own son, the malicious tin-founder, Christopher Kepler, accused his mother, and because she was the niece of a woman who was burnt for a witch at Weil. *Vide* a very interesting work, but one not much known in foreign countries, and compiled from newly-discovered manuscripts by Baron Breitschwert; 'Johann Keppler's Life and Works,' 1831, p. 12, 97—147 and 196. According to this book, Kepler, who always calls himself Keppler in his German letters, was not born on the 21st of December, 1571, in the town of Weil, as is generally supposed, but on the 27th of December, 1571, in Magstatt, a village of Wirtemberg. It is uncertain with respect to Copernicus, whether he was born on the 19th of January, 1472, or on the 19th of February, 1473, as Möstlin supposes, or according to Czynski, on the 12th of February of the same year. The year in which Columbus was born varied, according to different opinions, as much as 19 years. Ramusio placed it in 1430, Bernaldez, the friend of the discoverer, in 1436; the famous historian, Muñoz, in the year 1446.

338 (p. 350.)—Plut. de plac. Philosoph. ii. 14; Aristot. Meteor. xi. 8, de Cœlo, ii. 8. Respecting the theory of the spheres in general, and in particular respecting the *reciprocal* spheres of Aristotle, *vide* Ideler's Lecture upon Eudoxus, 1828, p. 49—60.

339 (352.)—A better view into the free motion of bodies, and into the independence of the direction of the earth's axis from the rotatory and progressing movement of the globe of the earth in its orbit, has freed the original system of Copernicus from the supposition of a *movement of declination*, or the so-called third movement of the earth (De Revol. Orb. Cœl. lib. i. cap. 11, triplex motus telluris). The parallelism of

the earth's axis is preserved in its annual course round the sun according to the law of inertia, without the application of a correcting epicycle.

[310] (p. 353.)—Delambre, Hist. de l'Astronomie ancienne, vol. ii. p. 381.

[311] (p. 353.)—*Vide* Sir David Brewster's opinion upon Kepler's optical works, in the Martyrs of Science, 1846, p. 179—182. (Compare Wilde, Hist. of Optics, 1838, Pt. i. p. 182—210). Although the discovery of the laws of refraction of light belongs to the Leyden Professor Willebrord Snellius (1626), who left it buried amongst his writings, yet its publication in a trigonometrical form was first effected by Descartes. *Vide* Brewster in the North-British Review, vol. vii. p. 207; Wilde, Hist. of Optics, Pt. i. p. 227.

[312] (p. 354.)—Compare two excellent treatises upon the discovery of of the telescope by Professor Moll, of Utrecht, in the Journal of the Royal Institution, 1831, vol. i. p. 319, and by Wilde at Berlin, in his Hist. of Optics, 1838, Pt. i. p. 138—172. The work of Moll, which is published in Dutch, is entitled: *Geschiedkundig Onderzoek naar die eerste Uitfinders der Vernkykers, uit de Aantekeningen van wyle den Hoogl. van Swinden zamengesteld door G. Moll.* (*Amsterdam*, 1831). Olbers communicated an extract from this interesting work to Schumacher's Journal for 1843, p. 56—65. The optical instruments, which Jansen delivered to Prince Moritz of Nassau and the Grand-Duke Albert, (who gave his to Cornelius Drebbel) were, as we learn from the letter of the ambassador Boreel, who as a child was frequently in the house of Jansen the spectacle-maker, and afterwards saw the instruments in the shop, microscopes of 18 inches in length, "through which small objects, when we look down from above, are wonderfully enlarged." The confusion between the microscope and telescope obscures the history of the discovery of these instruments. The letter of Boreel above alluded to (from Paris, 1655) makes it improbable, in spite of the authority of Tiraboschi, that the first discovery of the compound microscope belonged to Galileo. Compare, respecting the obscure history of these optical instruments, Vincenzio Antinori, in the Saggi di Naturali Esperienze fatte nell' Accademia del Cimento, 1841, p. 22—26. Huygens, the year of whose birth was scarcely 25 years after the supposed epoch of the discovery of the telescope, did not venture to speak with decision respecting the name of the first discoverer (Opera reliqua, 1728, vol. ii. p. 125). According to the

research made into archives by Van Swinden and Moll, Lippershey not only possessed on the 2nd of October, 1608, telescopes made by himself, but the French ambassador at the Hague, President Jeannin, writes to Sully on the 28th Dec. of the same year, "that he is treating with the Middleburg spectacle-maker, respecting a telescope, which he wished to send to King Henry IV." Simon Marius (Mayor of Gunzenhausen, one of the discoverers of Jupiter's satellites), narrates that a telescope was offered by a Belgian to his friend Fuchs of Bimbach, privy councillor of the Count of Ansbach, as early as the autumn of 1608, at Frankfurt on the Maine. Telescopes were manufactured in London in February 1610, and thus a year later than the date when Galileo completed his own instrument (Rigaud, on Harriott's Papers, 1833, p. 23, 26 and 46). They were at first called cylinders. Porta, the discoverer of the Camera obscura, spoke merely of the possibility "of seing everything nearer and larger, " by means of concave and convex glasses laid upon one another, (duo specilla ocularia alterum alteri superposita) ; so did also, at an earlier date, Frascastoro, a cotemporary of Columbus, Copernicus and Cardanus : but the discovery of the telescope may not be assigned to them. (Tiraboschi, Storia della Letter. ital. vol. xi. p. 467; Wilde, Hist. of Optics, Pt. i. p. 121). Spectacles had been known in Haarlem since the beginning of the 14th century, and a monument in the church of Maria Maggiore at Florence, alludes to Salvino degli Armati, who died in 1317, as their inventor (inventore degli occhiali). Some accurate notices of the use of spectacles by old men appear to have been made even in 1299 and 1305. The passages in Roger Bacon allude to the magnifying power of segments of spheres made of glass. *Vide* Wilde, Hist. of Optics, Pt. i. p. 93—96. and above, p. 458, note 244.

343 (p. 355.)—The above-named physician and mathematician of the province of Ansbach, Simon Marius, is also said to have constructed a telescope himself, in 1608, from a description of the power of one made in Holland by Fuchs Bimbach. Respecting Galileo's earliest observation of the mountains in the moon alluded to in the text, compare, Nelli, Vita di Galilei, vol. i. p. 200—206 ; Galilei, Opere, 1744, vol. ii. p. 60, 403 and (Lettera al Padre Cristoforo Grienberger, in materia delle Mintuosità della Luna) p. 409—424. Galileo finds a circular region in the moon, surrounded on every side by hills, in form like that of Bohemia. "Eundem facit aspectum Lunæ locus quidam, ac faceret in terris regio consimilis Boemiæ, si montibus altissimis, inque peri-

pheriam perfecti circuli dispositis occluderetur undique," vol. ii. p. 8). The measurements of the hills were made by the methods of the tangents of light. Galileo, and after him Helvetius, measured the distance of the summit of the mountain from the margin of the illuminated part, at the moment when the top was first touched by the rays of the sun. I find no mention made of the length of the shadows of mountains. He found that the elevation was *incirca miglia quattro*, and much higher than our mountains upon the earth. The comparison is remarkable, for at that time, according to Riccioli, they had such exaggerated opinions of the height of mountains, and one of the principal ones (that is, the earliest of those which were noted), the Peak of Teneriffe, was first accurately measured by trigonometry, by Feuillée in 1724. Galileo also believed in the existence of many seas and of an atmosphere round the moon, as did all observers until the end of the 18th century.

[344] (p. 355.)—I here again find it necessary (*vide* Kosmos, vol. i. p. 432—433), to remind the reader of the principle laid down by Arago: " Il n'y a qu'une manière rationnelle et juste d'écrire l'histoire des sciences, c'est de s'appuyer exclusivement sur des publications ayant date certaine; hors de là tout est confusion et obscurité." The remarkably late appearance of the *Fränkish Calender*, or *the Practica* (1612), and of the *Mundus Jovialis, anno* 1609, *detectus ope perspicilli Belgici*, (Feb. 1614), a work so important for astronomy, may at any rate give rise to the suspicion, that Marius made extracts from the Nuncius Sidereus of Galileo, (the date of whose dedication is March 1610,) or perhaps from some earlier epistolary communications. Galileo, irritated by the recollection of the trial against Balthasar Capra, a pupil of Marius, respecting the proportional circles, calls him " usurpatore del Sistema di Giove." Galileo also reproaches the *heretical protestant* astronomer of Gunzenhausen, because his earlier observations depended upon a change of the calendar. " Tace il Mario di far cauto il lettore, come essendo egli separato della Chiesa nostra, ne avendo acettato l'emendatione gregoriana, il giorno 7 di gennaio del 1610 di noi cattolici (the day on which Galileo discovered the satellites), è l'istesso, che il dì 28 di Decembre del 1609 di loro eretici, e questa è tutta la precedenza delle sue finte osservationi." (Venturi, Memorie e Lettere di Galileo Galilei, 1818, Pt. i. p. 279, and Delambre, Hist. de l'Astr. moderne, vol. i. p. 696). According to a letter which Galileo sent to the *Academia dei Lincei* in 1614, he wished, rather unlike a philosopher, to bring his complaint against Marius, before

the *Marchese di Brandeburgo.* Altogether, Galileo was well disposed towards German astronomers. "Gli ingegni singolari, che in gran numero fioriscono nell' Alemagna, mi hanno lungo tempo tenuto in desiderio di vederla;" he writes in March, 1611, (Opere, vol. ii. p. 44). It has always been a subject of wonder with me, that if Kepler in a conversation with Marius, was brought forward in a joking way, as a witness of the christening of the stars with the mythological names, Io and Callisto, he never makes mention of his countryman Marius, either in his Commentary to the 'Nuncius Sidereus nuper ad mortales a Galilæo missus,' which appeared in Prague in April, 1610, nor in his letters to Galileo, or to the Emperor Rudolph in the Autumn of 1610, but he everywhere speaks of "the glorious discovery of the Medicean stars by Galileo." He published his own observations respecting the satellites, from the 4th to the 9th of September, 1610, and gave as a title to a letter which appeared at Frankfort in 1611, the title: "Kepleri Narratio de observatis a se quatuor Jovis satellitibus erronibus quos Galilæus Mathematicus Florentinus jure inventionis Medicea Sidera nuncupavit. A letter from Prague (Oct. 25, 1610), written to Galileo, terminates with the following words, "Neminem habes, quem metuas æmulum." Compare Venturi, P. i. p. 100, 117, 139, 144 and 149. Baron von Zach, led away by an erroneous idea and by a very careless examination of all the precious manuscripts kept at Petworth, the seat of Lord Egremont, supposed that the distinguished astronomer and traveller in Virginia, Thomas Harriot, discovered the satellites of Jupiter simultaneously with Galileo, and perhaps even earlier. A more careful examination of Harriot's manuscripts, made by Rigaud, has taught us that his observations were not made on the 16th of January, but on the 17th of October, 1610, nine months after Galileo and Marius, (compare Zach, Corr. Astron. vol. vii. p. 105; Rigaud, Account of Harriott's Astronom. Papers, Oxford, 1833, p. 37; Brewster's Martyrs of Science, 1846, p. 32). An account of the earliest original observations of the satellites of Jupiter, which Galileo and his pupil Renieri set on foot, were found about two years ago.

345 (p. 356.)—It should be 73 years, for the prohibition of the Copernicus system by the congregation of the Index was in March 5, 1616.

346 (p. 357.)—Baron of Breitschwert, Keppler's Life, p. 36.

347 (p. 357.)—Sir John Herschel, Astronomy, § 465.

348 (p. 357.)—Galileo, Opere, vol. ii. (Longitudine per via de' Pianeti

Medicei), p. 435—506; Nelli, Vita, vol. ii. p. 656—688; Venturi, Memorie e Lettere di G. Galilei, P. i. p. 177. As early as 1612, scarcely two years after the discovery of Jupiter's satellites, Galileo boasted (certainly a little by anticipation) that he had completed the tables of these secondary planets "with the accuracy of a minute of time." A long diplomatic correspondence began, without coming to any conclusion, with the Spanish ambassador in 1616, and with the Dutch ambassador in 1636. The telescopes are said to have magnified about 40 to 50 times. In order to find the satellites whilst the ship was rolling about, and to keep them more easily (as he says) in the field of the telescope, he discovered in 1617 (Nelli, vol. ii. p. 663) the *Binocular telescope*, which usually is ascribed to the Capuchin, Schyrleus de Rheita, who was much experienced in optical matters, and who attempted to make a telescope of a magnifying power of 4000 times. Galileo made experiments with his *binoculo* (called by him also *celatone* or *testiera*), in the harbour at Leghorn, whilst there was a violent wind which tossed the vessel about. Also in the arsenal at Pisa he had works carried on in a machine, in which the observer of the satellites was preserved from all vibrations, by sitting in a boat, which floated in another filled with oil or water. (Lettera al Picchena de' 22 Marzo, 1617, Nelli, Vita, vol. i. p. 281; Galilei, Opere, vol. ii. p. 473, Lettera a Lorenzo Realio del 5 Giugno, 1637). The proof of the advantages which Galileo (Opere, vol. ii. p. 454) ascribes to his method, in the naval service, in preference to the method from the moon's distances by Morin, is very remarkable.

349 (p. 359.)—Arago in the 'Annuaire' for 1842, p. 460—476. (Découvertes des taches Solaires et de la rotation du Soleil). Brewster, (Martyrs of Science, p. 36 and 39), places the first observations of Galileo in October or November, 1610. Compare Nelli, Vita, vol. i. p. 324—384; Galileo, Opere, vol. i. p. lix. vol. ii. p. 85—200, vol. iv. p. 53. Respecting Harriot's Observations, *vide* Rigaud, p. 32 and 38. The Jesuit, Scheiner, who was called from Gratz to Rome, has been blamed because, in order to avenge himself on account of the literary contest respecting the discovery of the spots in the sun by Galileo, he had caused it to be insinuated to Pope Urban VIII, by another Jesuit, Grassi, that he, the Pope, had been introduced in the famous "Dialoghi delle Scienze Nuove," in the person of the ignorant simpleton *Simplicio*. (Nelli, vol. ii. p. 515).

[350] (p. 360.)—Delambre, Hist. de l'Astronomie moderne, vol. i. p. 690.

[351] (p. 360.)—In Galileo's letter to the Prince Cesi (25 May, 1612) the same opinion is expressed: Venturi. Pt. i. p. 172.

[352] (p. 360.)—*Vide* the talented treatise of Arago upon this subject in the "Annuaire" for the year 1842, p. 481—488. (The experiment with the Drummond light thrown upon the sun's disc, is mentioned by Sir John Herschel in the Astronomy, § 334).

[353] (p. 360.)—Giordano Bruno and Nic. of Cusa, compared by J. Clemens, 1847, p. 101.—Respecting the forms of Venus, *vide* Galileo, Opere, vol. ii. p. 53, and Nelli, Vita, vol. i. p. 213—215.

[354] (p. 362.)—Compare Kosmos, vol. i. p. 163 and 417.

[355] (p. 363.)—Laplace says of Kepler's theory of the measurement of vessels (Stereometria doliorum, 1615), "like the sand-reckoning of Archimedes, it has developed elevated ideas upon little matters." Kepler présente dans cet ouvrage des vues sur l'infini qui ont influé sur la révolution que la Géométrie a éprouvée à la fin du 17me siècle; et Fermat, que l'on doit regarder comme le véritable inventeur du calcul différentiel, a fondé sur elles sa belle méthode *de maximis et minimis*. (Précis de l'hist. de l'Astronomie, 1821, p. 95). Respecting the geometrical acuteness, which Kepler manifests in the five books of his Harmony of the World, *vide* Chasles, Aperçu Hist. des Méthodes en Géometrie, 1837, p. 482—487.

[356] (p. 363.)—Sir David Brewster well remarks in his Account of Kepler's method of investigating truth: "The influence of imagination as an instrument of research has been much overlooked by those who have ventured to give laws to philosophy. This faculty is of greatest value in physical inquiries. If we use it as a guide, and confide in its indications, it will infallibly deceive us; but if we employ it as an auxiliary, it will afford us the most invaluable aid." (Martyrs of Science, p. 215).

[357] (p. 363).—Arago in "the Annuaire," 1842, p. 434, (de la Transformation des Nébuleuses et de la Matière diffuse en Etoiles). Compare Kosmos, vol. i. p. 151, 161.

[358] (p. 364.)—Compare the ideas of Sir John Herschel upon the position of our planetary system, in Kosmos, vol. i. p. 160 and 417; also Struve, Etudes d'Astronomie stellaire, 1847, p. 4.

[359] (p. 364.)—Apelt says (Epochs of the History of Man, vol. i. 1845, p. 223): "The remarkable law of distances which bears generally the name of *Bode* (or of *Titius*), is Kepler's discovery, who calculated it by

the continual perseverance of many years, from the observations of Tycho de Brahe." *Vide* Harmonices Mundi, libri quinque cap. 3. Compare also Cournot in his Appendix to Sir John Herschel, Traité d'Astronomie, 1834, § 434, p. 324, and Fries, Lectures upon Astronomy, 1813, p. 325 (Laws of the distances of the Satellites of the Planets). The passages of Plato, Pliny, Censorinus and of Achilles Tatius in the *Prolegomena* to Aratus, are carefully collected in Fries, 'History of Philosophy,' vol. i. 1837, p. 146—150; in Martin, Etudes sur le Timée, vol. ii. p. 38; in Brandis, History of the Philosophy of the Greeks and Romans, Part ii. Sect. i. 1844, p. 364.

360 (p. 364.)—Delambre, Histoire de l'Astronomie moderne, vol. i. p. 360.

361 (p. 365.)—Arago in the "Annuaire" for 1842, p. 560—564, (Kosmos, vol. i. p. 104 and 105.

362 (p. 366.)—Compare Kosmos, vol. i. p. 145—151 and 414.

363 (p. 367.)—Annuaire du Bureau des Longitudes pour l'an 1842, p. 312—353 (Etoiles changeantes ou périodiques). In the 17th century, the following stars were known to be changeable; besides Mira Ceti (Holwarda, 1638), α Hydræ (Montanari, 1672), β Persei or Algol, and χ Cygni (Kirch, 1686).—Respecting that which Galileo called nebulæ, *vide* his *Opere*, vol. ii. p. 15, and Nelli, Vita, vol. ii. p. 208. Huygens very clearly indicates in his Systema Saturninum the nebula in the sword of Orion, and remarks generally respecting nebulæ: "cui certe simile aliud nusquam apud reliquas fixas potui animadvertere. Nam ceteræ nebulosæ olim existimatæ atque ipsa via lactea, perspicillis inspectæ, nullas nebulas habere comperiuntur, neque aliud esse quam plurium stellarum congeries et frequentia." We may collect from this passage, that the nebula in the constellation of Andromeda first described by Marius had not been attentively examined by Huygens or by Galileo.

364 (p. 369.)—Respecting the important law discovered by Brewster of the connection between the angle of perfect polarization and the refracting power of bodies, *vide* Philosophical Transactions of the Royal Society for the year 1815, p. 125—159.

365 (p. 369.)—*Vide* Kosmos, vol. i. p. 39 and 50.

366 (p. 369.)—Sir David Brewster in Berghaus and Johnson, Physical Atlas, 1847, Part vii. p. 5, (Polarization of the Atmosphere).

367 (p. 370.)—Respecting Grimaldi and Hooke's experiments to explain the polarizing power of soap bubbles by the interference of the rays of

light, *vide* Arago in the "Annuaire" for 1831, p. 164, (Brewster, Life of Newton, p. 53).

[368] (p. 370.)—Brewster, the Life of Sir Isaac Newton, p. 17. The year 1665 was fixed for the discovery of the "method of fluxions" according to the committee of the Royal Society of London, April 24, 1712, "One and the same with the differential method, excepting the name and mode of notation." Respecting the entire disagreeable contest with Leibnitz concerning the privity of discovery, which, wonderful enough, was mixed up with charges against Newton's orthodoxy, *vide* Brewster, p. 189—218. That white light contained all colours, was imagined by La Chambre in his work "La Lumière," (Paris, 1657), and by Isaac Vossius, who afterwards was Canon of Windsor, in a remarkable work, communicated to me two years ago in Paris by M. Arago, 'de Lucis natura et proprietate,' (Amstelod. 1662). Of this work Brande treats in his new examination of Gehler's Physical Dictionary, vol. iv. (1827), p. 43, and more circumstantially, Wilde in his Hist. of Optics, Part i. (1838), p. 223, 228 and 317. Isaac Vossius, however, considered sulphur, which we imagined to be mixed up in all bodies, to be the foundation of all colours, (cap. 25, p. 60).—In Vossii Responsum ad objecta Joh. de Bruyn, Professoris Trajectini, et Petri Petiti 1663, he says, p. 69: "Nec lumen ullum est absque calore, nec calor ullus absque lumine. Lux, sonus, anima (!), odor, vis magnetica, quamvis incorporea, sunt tamen aliquid. (De Lucis nat. cap. 13, p. 29).

[369] (p. 371.)—Kosmos, vol. i. p. 427, 428, vol. ii. p. 476, note 292.

[370] (p. 371.)—Bacon of Verulam, whose generally free and methodical notions were unfortunately connected with a very meagre knowledge of mathematics and physics, considering the time when he flourished, was very unjust against Gilbert: "Bacon shewed his inferior aptitude for physical research in rejecting the Copernican doctrine, which William Gilbert adopted." Whewell, Philos. of the Inductive Sciences, vol. ii. p. 378.

[371] (p. 371.)—Kosmos, vol. i. p. 197, and 433—434, note, 131 and 132.

[372] (p. 372.)—The first observations of this kind were (1590) made in the tower of St. Augustine's Church at Mantua. Grimaldi and Gassendi were acquainted with similar examples, always in geographical latitudes, where the inclination of the magnetic needle was very considerable. Respecting the first measurement of the intensity of the magnetic force

by means of the oscillation of the needle, compare my 'Relation Hist.' vol. i. p. 260—264, and Kosmos, vol. i. p. 431—433.

373 (p. 374.)—Kosmos, vol. i. p. 434—437, note 136.

374 (p. 375.)—Op. cit. vol. i. p. 192.

375 (p. 376.)—Respecting the most ancient thermometer, *vide* Nelli, Vita e commercio letterario di Galilei (Losanna, 1793), vol. i. p. 68—94; Opere di Galilei (Padova, 1744), vol. i. p. lv; Libri, Histoire des Sciences mathématiques en Italie, vol. iv. (1841) p. 185—197. The letters of Gianfrancesco Sagfredo and Benedetto Castelli, of 1613, 1615 and 1633, serve as proofs of the first comparative observations of the temperature (Venturi, Memorie e Lettere inedite di Galilei, Pt. i. 1818, p. 20.

376 (p. 376.)—Vincenzio Antinori in the Saggi di Naturali Esperienze fatte nell' Accademia del Cimento, 1841, p. 30—44.

377 (p. 376.)—*Vide* respecting the determination of the scale of the thermometer of the Academia del Cimento, and respecting the meteorological observations made by Father Raineri, a pupil of Galileo, during a period of 16 years, 'Libri in the Annales de Chimie et de Physique,' vol. xlv. 1830, p. 354, and a later work of a similar nature by Schouw, in his Tableau du Climat et de la Végétation de l'Italie, 1839, p. 99—106.

378 (p. 377.)—Antinori, Saggi dell' Accad. del Ciment. 1841, p. 114, and in the 'Aggiunte' at the end of the book, p. lxxvi.

379 (p. 378.)—Antinori, p. 29.

380 (p. 378.)—Ren. Cartesii Epistolæ Amstel. 1682, Pt. iii. Ep. 67.

381 (p. 378.)—Bacon's Works by Shaw, 1733, vol. iii. p. 441. (*Vide* Kosmos, vol. i. p. 343 and 470, note, 358).

382 (p. 379.)—Hooke's Posthumous Works, p. 364. (Compare my 'Relation hist.' vol. i. p. 199). Hooke, however, unfortunately assumed a difference in the speed between the rotation of the earth and the atmosphere, *vide* Posth. Works, p. 88 and 363.

383 (p. 379.)—But although according to Galileo's notion respecting the cause of the trade winds, we speak of the atmosphere being left behind, we must take care not to confound it with the ideas of Hooke and Hadley, as has recently been done. "Dicevamo pur' ora," as Galileo makes Salviati say in the 4th Dialogue (Opere, vol. iv. p. 311), "che l'aria, come corpo tenue, e fluido, e non saldamente congiunto alla terra, pareva, che non avesse necessità d'obbedire al suo moto, se non in quanto

l'asprezzà della superficie terrestre ne rapisce, e seco porta una parte a se contigua, che di non molto intervallo sopravanza le maggiori altezze delle montagne; la qual porzion d'aria tanto meno dovrà esser renitente allo conversion terrestre, quanto che ella è ripiena di vapori, fumi, ed esalazioni, materie tutte participanti delle qualità terrene: e per conseguenza atte nate per lor natura (?) a i medesimi movimenti. Ma dove mancassero le cause del moto, cioè dove la superficie del globo avesse grandi spazii piani, e meno vi fusse della mistione de i vapori terreni, quivi cesserebbe in parte la causa, per la quale l'aria ambiente dovesse totalmente obbedire al rapimento della conversion terrestre; sì che in tali luoghi, mentre che la terra si volge verso Oriente, si dovrebbe sentir continuamente un vento, che ci ferisse, spirando da Levante verso Ponente; e tale spiramento dovrebbe farsi più sensibile, dove la vertigine del globo fusse più veloce: il che sarebbe ne i luoghi più remoti da i Poli, e vicini al cerchio massimo della diurna conversione. L'esperienza applaude molto a questo filosofico discorso, poichè ne gli ampi mari sottoposti alla Zona torrida, dove anco l'evaporazioni terrestri mancano (?), si sente una perpetua aura muovere da Oriente . . . ."

384 (p. 379.)—Brewster in the Edinburgh Journal of Science, vol. ii. 1825, p. 145. Sturm described the differential thermometer in a little work entitled 'Collegium experimentale curiosum,' (Nuremberg, 1676, p. 49). Respecting Bacon's law of the change of the wind, which Dove first extended to both zones, and understood in its intimate connection with the causes of all currents in the atmosphere, *vide* the complete treatise by Mancke in the new edition of Gehler's Physical Dictionary, vol. x. p. 2003—2019, and 2030—2035.

385 (p. 380.)—Antinori, p. 45, and in the 'Saggi,' p. 17—19.

386 (p. 380.)—Venturi, Essai sur les ouvrages physico-mathématiques de Léonard de Vinci, 1797, p. 28.

387 (p. 380.)—Bibliothèque Universelle de Genève, vol. xxvii. 1824, p. 120.

388 (p. 381.)—Gilbert de Magnete, lib. ii. cap. 2—4, p. 46—71. In the interpretation of the usual nomenclature it says: "Electrica quæ attrahit eadem ratione ut electrum; versorium non magneticum ex quovis metallo, inserviens electricis experimentis." In the text we find: "magneticè ut ita dicam, vel electricè attrahere (vim illam electricam nobis placet appellare . . .) (p. 52); effluvia electrica, attractiones electricæ. The abstract expression *electricity* is not found in the 18th century, any

more than the barbarous word *magnetism*. Respecting the derivation of ἤλεκτρον, given in Plato's Timæus, p. 80 *c.*, "the *attractive and the drawing stone*," from ἕλξις and ἕλκειν, and the probable transition through the term ἕλκτρον, *vide* Buttmann, Mythologus, vol. ii. 1829, p. 357. From the theoretical opinions laid down by Gilbert, which are not always expressed with the same degree of clearness, I choose the following: "Cum duo sint corporum genera, quæ manifestis sensibus nostris motionibus corpora allicere videntur, Electrica et Magnetica; Electrica naturalibus ab humore effluviis; Magnetica formalibus efficientiis, seu potius primariis vigoribus, incitationes faciunt.—Facile est hominibus ingenio acutis, absque experimentis et usu rerum labi, et errare. Substantiæ proprietates aut familiaritates, sunt generales nimis, nec tamen veræ designatæ causæ, atque, ut ita dicam, verba quædam sonant, re ipsâ nihil in specie ostendunt. Neque ista succini credita attractio, a singulari aliquâ proprietate substantiæ, aut familiaritate assurgit: cum in pluribus aliis corporibus eundem effectum, majori industria invenimus, et omnia etiam corpora cujusmodicunque proprietatis, ab omnibus illis alliciuntur." (De Magnete, p. 50, 51, 60 and 65). Gilbert's best works date between 1590 and 1600. Whewell rightly accords to him an important place among those whom he calls "Practical reformers of the positive sciences." Gilbert was physician to Queen Elizabeth and James I, and died in 1603. A second work appeared after his death, "De Mundo nostro sublunari Philosophia nova."

[389] (p. 382.)—Brewster, Life of Newton, p. 307.

[390] (p. 385.)—Rey properly only speaks of the access of air to the oxide; he did not know that the oxide itself (then called metals converted into earth) was a mere union of the metals and air. According to him, the air makes the calcined metal heavier, like sand increases in weight, when water is mixed with it. The calcined metal is, however, capable of being saturated with air. L'air espaissi s'attache à la chaux, ainsi le poids augmente du commencement jusqu'à la fin; mais quand tout en est affublé, elle n'en sçauroit prendre d'avantage. Ne continuez plus vostre calcination soubs cet espoir, vous perdriez vostre peine." Rey's work, however, contains the first approach to a better explanation of this phenomenon, the complete understanding of which has effected a reformation in the whole system of chemistry. *Vide* Copp, History of Chemistry, Pt. iii. p. 131—133. (Compare also in the same, Pt. i. p. 116—127, and Pt. iii. p. 119—138, and p. 175—195).

391 (p. 387.)—Priestley's last complaint upon that "which Lavoisier is said to have appropriated to himself," is seen in the little work, 'The Doctrine of Phlogiston established' (1800), p. 43.

392 (p. 388.)—John Herschel, Discourse on the Study of Natural Philosophy, p. 116.

393 (p. 388.)—Humboldt, Essai géognostique sur le Gisement des Roches dans les deux hémisphères, 1823, p. 38.

394 (p. 389.)—Steno de Solido intra Solidum naturaliter contento, 1669, p. 2, 17, 28, 63, and 69, (Fig. 20—25).

395 (p. 389.)—Venturi, Essai sur les ouvrages physico-mathématiques de Léonard de Vinci, 1797, § 5, No. 124.

396 (p. 390.)—Agostino Scilla, la vana Speculazione disingannata dal senso, Nap. 1670, Tab. xii. Fig. 1. Compare Joh. Müller, Report on the fossil remains of a Hydrarchus, collected by M. Koch in Alabama, (the Basilosaurus of Harlam, 1835; the Zeuglodon of Owen, 1839; the Squalodon of Grateloup, 1840; the Dorudon of Gibbes, 1845). The Report was read in the Royal Academy of Sciences, at Berlin, April—June, 1847. These precious remains of the antedeluvian animal collected in Alabama (Washington country, and not far from Clarksville) have, by the munificence of our King, since 1847 been the property of the Zoological Museum at Berlin. Besides in Alabama and South Carolina, portions of the Hydrarchus have been also found in Europe at Leognan, near Bordeaux, and not far from Linz on the Danube, and in 1670 in Malta.

397 (390.)—Martin Lister in the Philosophical Transactions, vol. vi. 1671, No. lxxvi. p. 2283.

398 (p. 390.)—*Vide* a luminous development of the early progress in paleontology, in Whewell, History of the Inductive Sciences, 1837, vol. iii. p. 507—545.

399 (p. 391.)—Leibnitz's Historical Ideas and Poems, edited by Pertz, 1847, (in his entire works; History, vol. iv). Respecting the first sketch of the Protogæa of 1691, and the subsequent elaboration of it, *vide* Tellkampf, Annual Report of the Academy (Bürgerschule) at Hanover, 1847 p. 1—32.

400 (p. 393.)—Kosmos, vol. i. p. 175.

401 (p. 393.)—Delambre, Hist. de l'Astronomie mod. vol. ii. p. 601.

402 (p. 393.)—Kosmos, vol. i. p. 174. Delambre was the first to explain, in his Hist. de l'Astron. mod. (vol. i. p. lii. and vol. ii. p. 558), the contest respecting priority in the discovery of the flattening, with reference

to a treatise read by Huygens before the Paris Academy in 1669. Richer's return to Europe took place in the year 1673, but his work was not printed till 1679; and when Huygens left Paris in 1682, he had then just written the *Additamentum* to his treatise of 1669, which was so late published, having at the time before his eyes the results of Richer's experiments with the pendulum, and Newton's great work: 'Philosophia Naturalis Principia Mathematica.'

403 (p. 394.)—Bessel in Schumacher's Annual for 1843, p. 32.

404 (p. 394.)—Wilhelm von Humboldt's entire works, vol. i. p. 11.

405 (p. 401.)—Schleiden's Principles of Scientific Botany, Pt. i. 1845, p. 152, Pt. ii. p. 76; Kunth, Handbook of Botany, Pt. i. (1847), p. 91—100 and 505.

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VI. Epoch of the grand discoveries in the ocean: America and the Pacific Ocean.—Events, and the extension of scientific knowledge, which prepared the way for these discoveries. Although an acquaintance of the people of Europe with the western hemisphere is the principal subject of this section, the really first discovery of America in the northern and temperate zones by the Normans, must be completely distinguished from its subsequent discovery in the tropical regions. Whilst the Caliphat still flourished at Bagdad under the Abbassides, America was discovered by Leif, the son of Erick the Red, at the 41½° north latitude. The Färöer Islands and Iceland, accidentally discovered by Naddod, are to be considered as intermediate stations, or as commencing points for the voyage to American Scandinavia. Also the eastern coast of Greenland in Scoresby Country (Svalbord), the east coast of Baffin's Bay, as far as 70°—55′, and the entrance of Lancaster Sound and Barrow Straits were visited. Earlier (?) Irish discovery of America. The White-Man's Land between Virginia and Florida. Whether before the time of Naddod and Ingolf's colonization of Ireland, this island was inhabited by the Irish (white men from American Great Ireland), or by the Irish priests (Papar, the Clerici of Dicuil) driven out of the Färöer Islands by the Normans? The national treasure of the oldest traditions of the north of Europe, endangered by disturbances in their original country, were conveyed to Iceland,

which enjoyed a free constitution for three centuries and a half, and were there preserved for future ages. We know the trading communication between Greenland and New Scotland (the American Markland) as far back as 1347; but as Greenland lost its republican constitution as early as 1261, and all intercourse with strangers and with Iceland was forbidden, when it became the possession of the Crown of Norway, we need not wonder so much that Columbus, when he visited Iceland in February 1477, obtained no account of the new continent lying to the westward. Between the Norwegian haven, Bergen, and Greenland, there was commercial intercourse until 1484, p. 264—275, and notes, p. 452—457. As regards the history of the world, the second discovery of America in its tropical region by Christopher Columbus, was altogether different from the barren event of the first discovery by the Normans, although Columbus in his search for a nearer way to East-Asia, had not the intention of finding a new continent, and like Amerigo Vespucci, believed, until the day of his death, that he had only arrived at the eastern coast of Asia. The influence which the nautical discoveries at the end of the 15th and beginning of the 16th centuries exerted in increasing the store of ideas, is only intelligible by casting a look at those centuries which separate the age of Columbus from the flower of scientific advancement among the Arabs. That which gave its peculiar characteristic to the age of Columbus—namely, its continuous and successful desire for an extended acquaintance with Nature—was the appearance of a few bold men (Albertus Magnus, Roger Bacon, Dun Scotus, William of Occam), who roused men to free and independent thought, and to the investigation of individual natural phenomena; a renewed acquaintance with the writers of Grecian literature; the discovery of printing; the embassy of monks to the princes of the Mongolians, and the mercantile journeys to Eastern-Asia and Southern-India (Marco Polo, Mandeville, Nicolo de' Conti); the improvement of navigation; the use of the sea-compass, or the acquaintance with the north and south direction of the magnetic needle, which was due to the Chinese through the Arabians, p. 275—295, and notes, p. 457—466. Early voyages of the Catalanians to the western coasts of tropical Africa, the discovery of the Azores, map of the world of Picigano of 1367. Relation of Columbus to Toscanelli, and Martin Alonso Pinzon. Lately known map of Juan de la Cosa. South Sea and its islands,

p. 295—313, and notes, p. 466—473. Discovery of the magnetic line, where there is no variation, in the Atlantic. Notice of the inflexion of the isothermic lines one hundred leagues west of the Azores. A physical line of demarcation converted into a political one: line of demarcation of Pope Alexander VI. of May, 1493. Knowledge of the distribution of heat; the boundaries of eternal snow known as a function of geographical latitude. Movement of the water in the Atlantic. Vast sea-weed banks, p. 313—324, and notes, p. 473—477. Extended view of the world; acquaintance with the stars of the southern sky; a knowledge rather contemplative than scientific! Perfection of the methods of determining the position of a ship; the political necessity of determining the position of the Pope's line of demarcation, increases the impulse to discover new methods of determining the longitude. The discovery and first colonization of America, and the voyage to the East Indies round the Cape of Good Hope coincide in time with the most flourishing condition of art, with the attainment of spiritual freedom by the religious reformation, the prelude to grand political changes. The boldness of the mariner of Genoa is the first step in this immeasurable chain of pregnant events. Accident, and not deceit or jealousy on the part of Amerigo Vespucci, deprived America of the name of Columbus. Influence of the new continent upon the political constitutions, ideas, and inclinations of the people in the Old World, p. 324—338, and notes, p. 477—487.

VII. Epoch of the grand discoveries in the heavens by the employment of the telescope; preparation for these discoveries by a more correct view of the structure of the universe—Nicholas Copernicus was observing with the astronomer Brudzewski at Cracow, when Columbus discovered America. Chain of ideas in the 16th and 17th centuries by Peurbach and Regiomontanus. Copernicus did not bring forward his system of the universe as an hypothesis but as a truth which was not to be refuted, p. 339—350, and notes, p. 487—496. Kepler and the empirical laws of the orbits of the planets which he discovered, p. 350—353, and notes, p. 496 (also p. 363—365, and notes, p. 498—499). Discovery of the telescope; Hans Lippershey, Jacob Adriaansz, (Metius), Zacharias Jansen. First fruits of telescopic vision: Mountains in the moon: nebulæ and the milky way, the four satellites of Jupiter: triple form of Saturn; crescent shaped form

of Venus; spots on the sun and the period of its rotation. The discovery of the little system of Jupiter is a remarkable epoch for the fate of astronomy and its secure foundation. The satellites of Jupiter cause the discovery of the speed of light, and the knowledge of this speed leads to the explanation of the ellipse of aberration of the fixed stars, i. e. to the perceptible proof of the translator movement of the earth. The discovery of Saturn's moons by Huygens and Cassini, of the zodiacal light as a revolving separate nebulous circle by Childrey, of the changing light of the fixed stars by David Fabricius, Johann Bayer and Holwarda, followed the discoveries of Galileo, Simon Marius, and Johann Fabricius. Starless spot of Andromeda described by Simon Marius, p. 353—368, and notes, p. 496—502. The 17th century owes its principal splendour in its beginning, to the sudden extension of astronomical knowledge by means of Galileo and Kepler, and at the end to the progress of pure mathematics by Newton and Leibnitz; at the same time the principal part of the physical problems respecting the processes of light, heat and magnetism experienced a beneficial and fertilizing degree of care. Double refraction and polarization; traces of the knowledge of the interference of light by Grimaldi and Hooke. William Gilbert separates magnetism from electricity. Knowledge of the periodical advance of the lines without variation. Halley's early supposition, that the polar light (terrestrial light) is a magnetic phenomenon. Galileo's thermoscope and its employment in a series of regular daily observations in stations at different elevations. Experiments on the radiation of heat. Torricelli's tubes and measurement of altitudes by the position of the mercury in them. Knowledge of currents of air, and of the influence of the rotation of the earth upon them. Laws of the change of the winds guessed at by Bacon. Happy but short-lived influence of the Academia del Cimento on the establishment of natural philosophy by the way of experiment. Attempts to measure the moisture of the atmosphere: condensing hygrometers. Electricity; terrestrial electricity; Otto of Guerike sees the first light in electricity purposely induced—Beginnings of pneumatic chemistry: observed increase in weight by the oxidation of metals; Cardanus and Jean Rey, Hooke and Mayow. Ideas upon the matter of the atmosphere (Spiritus nitro-aëreus) added to the metals undergoing calcination, and necessary for combustion and animal respiration. Influence of physical and chemical knowledge upon the establishment of geology (Nicholas Steno, Scilla, Lister);

elevation of the bottom of the sea and of the coasts. In the greatest of all geological phenomena, in the mathematical form of the earth, the conditions of its primitive age are to be recognised; i. e. the former fluidity of the revolving mass, and its hardening into a spheroid. Measurement of degrees and experiments upon the pendulum in different latitudes. Flattening at the poles. The form of the earth was known to Newton from theoretical grounds, and thus the power was discovered, the effects of which are followed by Kepler's laws as a necessary consequence. The discovery of such a power, the existence of which is developed in Newton's immortal work of the Principia, is almost simultaneous with the way opened to new mathematical discoveries by the infinitesimal mode of calculation, p. 368—395, and notes, p. 502—507.

VIII. Multiplicity and intimate union of scientific achievements in modern times. Retrospect of the principal steps in the history of a contemplation of the world, which we connected with great events. The manifold connection of all our present knowledge renders the separation and limitation of each branch of science more difficult. The intellect brings forth great things almost without any external inducement, by its innate power in every direction. The history of the physical sciences thus gradually unites with the history of the idea of Nature as a whole, p. 398—402, and notes. p. 508.

THE END.

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